Global Livestock CRSP
Annual Report 2003

Edited by Jenni Strand
Cover Photo by Montague W. Demment
Designed by Susan L. Johnson

Published by the Global Livestock CRSP,
Management Entity, University of California, Davis,
258 Hunt Hall, Davis, California 95616.
Telephone: (530) 752-1721. Fax: (530) 752-7523.
Email: glcrsp@ucdavis.edu.
Web Site: http://glcrsp.ucdavis.edu.

The rich bird life of the alkaline Rift Valley lakes of East Africa is an important component of the region's biodiversity that attract thousands of tourists. These lakes are closed hydrological systems into which waterflows are critical to their maintenance and survival. In such systems, the nature of the quality and quantity of water inputs is an extremely critical component of their survival as an ecosystem. Our SUMAWA project addresses the contribution of the Njoro River to Lake Nakuru, one of the region's most visited lake-based national parks. The ability to understand and influence the impacts of land use, development, and population demands are vital to the future of these Rift Valley lakes and their biodiversity and are the objectives of the SUMAWA project.

This publication was made possible through support provided in part by US Universities, host country institutions and the Office of Agriculture and Food Security, Global Bureau, United States Agency for International Development, under Grant No. PCE-G-00-98-00036-00. The opinions expressed herein are those of the authors and do not necessarily reflect the views of the U.S. Agency for International Development.

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PREFACE

Each year, the Global Livestock Collaborative Research Support Program publishes an annual report in compliance with grant requirements. The 2003 Annual Report documents work completed during the fiscal year, October 2002 - September 2003. 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.

Jenni Strand
Annual Report Coordinator

Foreword: Time and Development

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

We have a national obsession with time. Technology has connected us to each other, to information, to pleasure and tragedy so instantaneously that as we click the remote through our daily lives, we demand instantaneous satisfactions, responses, and results. I am not sure this brings us a better life, but it certainly affects how we view development.

The pace of this style of life has both a positive and negative impact on those of us working in international development. There is no question that the demand for results from our international assistance is both reasonable and required, but the timeframe for our expectations is often inappropriate and counterproductive. The "results now" attitude that has evolved in international affairs can be a dangerous and unproductive approach and often results, strangely enough, from a lack of perspective on our part to our own history and development as a nation. In a recent review of his experience in international development, Carl Eicher concludes: "fifty years of donor experience in Africa has shown that successful institution building is an accretionary and almost invisible process that requires a multi-generational time span and learning from experience." The recent frustration expressed in the media and reflected in political circles with the delays in agreeing on an Afghan constitution is an interesting example. We may forget that the time it took to see our own Constitution evolve from the Articles of Confederation (1775) to a ratified Constitution (1789) was years, while the Afghans have debated and delivered in months.

The aftermath of the Iraqi war is also illustrative. Many expected that a war won would quickly translate into a nation, productive and peaceful, that would set an example for the Middle East. The aftermath of the war, the seemingly slow progress to national development (both in Iraq and Afghanistan) strikes many Americans as a failure and a frustration.

Unlike our ability at home to get what we want pretty much when we want it, the pace of national development is slow. The development of constitutions, institutions, and human capital takes decades not months. Bringing new order to a society whose framework has been destroyed or is totally unadapted to the modern environment is a lifelong challenge.

The problem facing international development is that the time dimension is not well appreciated by those controlling the flow of funding, and by the general public. We expect that with the infusion of relatively small amounts of funds over short periods of time that nations will develop in measurable ways. How long has it taken for us to develop? I expect that many of those controlling the purse strings for national development here would have given up on the early stages of our development process in the 1800s. Fortunately for us, we had a remarkable combination of

people, natural resources, and a relatively clean historical slate that allowed our accelerated pace of development. But that said, this process took decades (if not a century) that included our worst war and secession.

Development takes time. In this year, we have at the GL-CRSP brought to fruition an idea, an important concept, that has taken 15 years to nurture: the recent publication of a volume of the *Journal of Nutrition* devoted to our work on the link between human nutrition, human capacity, and national development. The initial seeds for the concept were planted in the 1980s. USAID funded the Nutrition CRSP, which did a remarkable study to identify factors that affected the development of children. The work was done in three developing countries on two continents and indicated the importance of animal source foods on the cognitive development of children. The research was correlative but the relationship strong, indicating that animal source foods (ASF) were the only dietary factor that predicted cognitive performance.

In the early 1990s, a group here at UC Davis attempted to advance the link between food-based solutions and economic development focused on the poor. Historically, an academic barrier has existed between human nutrition and agriculture, and in development the interaction between agriculture, human nutrition, and health has been less than optimal. The group sought means to link these areas by emphasizing the importance of food systems to ensure sustainable economic development and nutrient supply.

In 1996 in East Africa, the GL-CRSP priority-setting process identified the micronutrient/cognitive capacity link as a high priority activity. In that year we funded a project that conducted a large and complex intervention project to determine directly the impact of ASF on the development of Kenyan children. The results are a testimony to the impressive impact of small amounts of ASF on children's capacity that will impact all aspects of their productive lives. Hopefully, the wide dissemination of these results will have a major influence on how we plan development interventions in nutrition and agriculture. It took time and long-term commitments to develop this concept.

The message here, whether it be rebuilding a nation or understanding how to develop a productive person, is that these processes take time. By succumbing to the pace we have defined for ourselves, we are losing our perspective on the pace of development for others and we are apt to make bad development investments and poor program design. The recent hints that USAID will devote more resources to human capacity building are encouraging. Both research and human capacity building are sustainable interventions that have long-term impacts.

Most all of us in the development community have interacted with a whole cohort of individuals in developing countries who were trained at U.S. universities. For the most part of 30 years, they have been the engines of development in their countries but their lifetime impact has never been measured or recorded. Research produces the objective knowledge that drives development. Like human capacity, its impacts are diffuse and long-term, but no one in our society would argue that research is not the foundation of our economic development.

The CRSP programs represent USAID's commitment to a longer-term perspective. While this approach is often challenged within the Agency, the maintenance of the long-term

visions of research and human capacity building are the result of a dynamic tension between short-term pressures and long-term development needs. We, as Americans, should try to understand that the pace of our lives should not be a force to dictate our expectations about development. We should develop long-term strategies, have confidence in the fundamentals of development, and stick to our vision long enough to be successful.

References

Eicher, C.K. 2004. Flashback: fifty years of donor aid to African agriculture. Revised version of a paper presented at an International Policy Conference "Successes in African Agriculture: Building for the Future," sponsored by InWent, IFPRI, NEPAD, and CTA. Pretoria, South Africa, December 1-3, 2003.

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 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 14 U.S. universities, 2 international agricultural research centers, 5 international research organizations, and 91 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 nine 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 U.S. land-grant universities and collaborative partnerships with international organizations. Four characteristics ensure the effectiveness of this model: 1) Collaboration with U.S. land-grant universities; 2) International training; 3) Long-term scientific relationships; and 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. Each team was charged with refining its problem model through in-field explorations. To ensure grassroots input, over 20 regional workshops involving 35 countries were conducted during the assessment period. The teams submitted final proposals, competing to be in GL-CRSP's current proposal, and winners were selected. The process was designed to be problem-driven and has 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 six 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, 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: Implications for People, Policy, Conservation, and Development in East Africa,* headed by Colorado State University, addresses the relationship between pastoralists and wildlife conservation in the context of the unpredictability of semi-arid environments. This project adapts models already in use in U.S. national parks to assist policymakers 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, 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, and provide higher productivity and stability to their livestock systems as well as greater protection for the biodiversity in their environments.

The project, *Managing National Parks in the Context of Changing Human Populations and Economics*, headed by the Big Sky Institute at Montana State University, addresses the parallel management challenges facing Yellowstone and Serengeti National Parks in the interaction of multiple land uses, predominantly cattle grazing and agriculture outside the parks, and the maintenance of biodiversity and ecosystem integrity. The focus is on people around the parks, as much as on the animals inside.

The project, *Multidisciplinary Research for Sustainable Management of Rural Watersheds: The River Njoro, Kenya*, headed by the University of Wyoming, addresses one of East Africa's most important natural resource management issues: water. The project builds the scientific and community capacity required to manage natural resources that are under attack by a growing population, increased livestock grazing, and short-term extraction strategies that threaten a watershed and a major national park.

The project, *Livestock Trade in Ethiopia and Kenya*, headed by Syracuse University, seeks to understand how terminal livestock markets function, in order to better understand how to connect interventions at the local level to national markets, which will ultimately lead to improvements in the ability of pastoralists to respond to drought.

Central Asia and Latin America

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 such as 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, 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 project uses 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, 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.

Small Grant Program

In Central Asia, four small grant projects are focused on the livestock sector and environment. The project, *Linking Sheep Producers and Markets*, headed by University of Wisconsin-Madison, compares the production economics and marketing environment for fine wool, meat, and meat/wool breeds of sheep. This project will analyze the marketing opportunities surrounding each of these three production strategies and collaborate to produce extension materials for local producer support groups about the findings. A second project, *Feasibility of Market Development and Support Services for Livestock Products in Kazakhstan and Kyrgyzstan*, headed by Colorado State University, addresses the problem of developing markets for fine wool and cashmere in Kazakhstan and Kyrgyzstan. Goals include improving marketing from the perspective of traders, domestic processors, and researchers. A third project, *Co-Benefits of Grassland Regeneration of Abandoned Wheat Areas for Carbon Sequestration, Livestock Productivity, Biological Conservation, and Social-Economic Development*, also headed by Colorado State University, is evaluating and modeling how changes in the seasonal grazing mobility of livestock in the Kostanai steppe region of northwest Kazakhstan affect carbon sequestration, vegetation composition, and rangeland productivity. The fourth project, *Improving Market Infrastructure Through Wool Pools in Kazakhstan*, headed by University of Wisconsin-Madison, assists Kazakh wool farmers with the development of market institutions, namely wool pools and wool grading technologies. This project helps Kazakh sheep farmers create wool pools and wool grading systems using the organizational technologies and experiences of U.S. sheep farmers.

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 U.S. institutions is required. The projects also receive substantial contributions from host country collaborators, U.S. universities, and other leveraged funds.

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)

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 U.S. 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 overseeing 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 Coordinating 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.

Program Administrative Council

David Acker, CHAIR
Iowa State University
Gilles Bergeron, FANTA
Salvador Fernandez-Rivera, ILRI
Seyfu Ketema, ASARECA
Robin Mearns, The World Bank
Dennis Poppi, The University of Queensland

External Evaluation Panel

Tom Thurow, CHAIR
University of Wyoming
Ahmed Sidahmed, IFAD
Bernie Engel, Purdue University
Keith Moore, Virginia Polytechnic Institute & State University

USAID

Joyce Turk, Program Officer

U.S. Lead Principal Investigators

Malcolm Childress,
University of Wisconsin - Madison
Layne Coppock, Utah State University
Kathleen Galvin, Colorado State University
Lisa Graumlich, Montana State University
Emilio A. Laca, CHAIR
University of California - Davis
John McPeak, Syracuse University
Scott Miller, University of Wyoming
Timothy Moermond,
University of Wisconsin - Madison
Dennis Ojima, Colorado State University
Jerry Stuth, Texas A&M University System
David Swift, Colorado State University
David Thomas,
University of Wisconsin - Madison

Management Entity

Montague W. Demment, Program Director
Susan L. Johnson, Assistant Director
Jenni R. Strand, Program Coordinator
Cathy Miller, Financial Officer
Quin Martin, Student Assistant

Collaborating Institutions

Central Asia

Kazakhstan
Barayev Research Institute of Grain Farming
Central Asian Regional Environmental Center (CAREC)
Kazakh Technological Research Institute of Sheep Breeding
Ministry of Science - Academy of Science of the Republic of Kazakhstan (MS ASRK)
National Federation of Private Farmers of Kazakhstan
Research Institute of Feed Production and Pastures

Uzbekistan
Academy of Sciences - Samarkand Division
Institute of Karakul Sheep Breeding and Desert Ecology
Karakul Sheep Research Institute
Uzbek Livestock Research Institute
Uzbek Research Institute of Market Reforms
Uzbek Sericulture Research Insititute

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

Kyrgyzstan
Center for Economic and Social Research in Kyrgystan (CASE)
Kyrgyz Research Institute of Sheep Breeding
Kyrgyz Livestock Research Institute
Kyrgyz Sheep Breeders Association

East Africa

African Wildlife Foundation
Crisis Mitigation Office - ASARECA
FARMAfrica

Ethiopia
Adami Tulu Agricultural Research Center
Borana Lowlands Pastoral Development Project
Ethiopian Agricultural Research Organization (EARO)
Holetta Research Center
Livestock Policy Analysis Program (LPAP)
Mekelle University
Oromia Agricultural Development Bureau (OADB)
Oromia Agricultural Research Institute (OARI)
Oromia Cooperative Promotion Bureau (OCPB)
Oromia Pastoral Development Commission (OPDC)
Oromia Regional Agricultural Office
Save the Children - UK
Save the Children - USA
USAID Mission to Ethiopia
Volunteers in Overseas Cooperative Action (VOCA)

Tanzania
Executive Pastoral Council, Ngorongoro
Inuyat e-Maa
Livestock Production Research Institute (LPRI)
Maasai Advancement Association
Mpwapwa Agricultural Research Institute
Ngorongoro Conservation Area Authority
Selian Agricultural Research Institute
Sokoine University
Tanzania National Parks (TANAPA)

Tanzania Wildlife Research Institute (TAWIRI)
Ukiriguru Agricultural Research Institute
University College of Lands and Architechtural Studies (UCLAS)
University of Dar es Salaam

Kenya
African Conservation Centre (ACC)
Amboseli NP
Amboseli/Tsavo Group Ranch Conservation Association
Arid Lands Resource Management Project (ALRMP)
Community Initiatives Facilitation and Assistance (CIFA)
Drought Preparedness Intervention and Recovery Program, Office of the President
Egerton University
Fisheries Department
K-REP Development Agency
Kenya Agricultural Research Institute (KARI)
Kenya Wildlife Service (KWS)
Kenyatta University
Masai Mara Game Reserve
Meru NP
Ministry of Agriculture and Rural Development
Moi University
Mpala Research Centre
Naivasha Animal Husbandry Research Centre
National Dryland Farming Research Center
National Environment Management Authority
National Range Research Center
Netherlands Development Organization (SNV) - Isiolo
PACT CORE
Resources Conflict Institute (RECONCILE)
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
National Agricultural Research Organization
Serere Animal and Agricultural Production Institute

Latin America

Servicios Agro-Informaticos de Apoyo a la Planificacion para la Uso y Manejo de los Recursos Naturales (AGROSIG), Bolivia
Alianza Jatun-Sacha/Centro de Datos para la Conservacion (CDC), Ecuador
Centro Interdisciplinario para 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 Conservacion de la Biodiversidad (IMECBIO), CUCSUR, Universidad de Guadalajara, Mexico
Comunidad de Estudios JAINA, Bolivia
Terra Nuova, Ecuador

International

Centre de Cooperation Internationale en Recherce Agronomique pour le Developpement (CIRAD)
International Center for Agricultural Research in Dry Areas (ICARDA)
International Livestock Research Institute (ILRI)
Istituto Oikos (Italy)
Macaulay Institute (Scotland)
Agricultural Research Organization - New Ya'ar Research Center (Israel)
SOFRECO - Clichy

United States
Colorado State University
Cornell University
United States Geological Survey (USGS) - Earth Resources Observation Systems (EROS) Data Center
Iowa State University
Montana Fish, Wildlife, and Parks
Montana State University
South Dakota State University
Texas A&M University
Syracuse University
University of California, Davis
University of California, Los Angeles
University of Kentucky
University of Wisconsin - Madison
University of Wyoming
United States Department of Agriculture (USDA) - ARS Forage and Range Research Laboratory
Utah State University
Yale University
Yellowstone National Park

Early Warning System for Monitoring Livestock Nutrition and Health for Food Security of Humans in East Africa

Narrative Summary

Developing methodology and technology to address the informational needs of pastoral communities, relative to emerging forage conditions in response to climatic conditions, has been the major thrust of the GL-CRSP Livestock Early Warning Systems (LEWS) project in East Africa. The LEWS team, led by Texas A&M University, in collaboration with a large network of National Agricultural Research Systems (NARS), non-governmental organizations (NGOs), and development agencies in Ethiopia, Kenya, Tanzania, and Uganda, has assembled an integrated suite of technology that is capable of providing estimates of livestock forage availability, deviation from normal, and percentile ranking for a large portion of these four countries. The system uses the PHYGROW plant growth model and is driven by satellite-based weather. Using geo-statistics, point-based model simulations are linked with satellite greenness images (NDVI) to create maps of forage supply and its deviation from normal every ten days using an automated analysis system. When coupled with a 90-day forecasting system, information such as current forage conditions relative to historical conditions, conditions at the same time during the previous year, and likely forage response in the next 90 days can be provided. This information is updated every ten days with situation reports and maps distributed via WorldSpace radios, email, Internet, CDs, and newsletters, impacting over 400 organizations and 300 decision-makers in the region. Critical to the process is automation of the modeling process, in which biophysical models are linked with satellite monitoring weather systems in collaboration with the Famine Early Warning System Network (FEWS NET), Earth Resources Observation Systems (EROS), and National Oceanographic and Atmospheric Administration Rainfall Estimate (NOAA RFE) satellite-based weather data. These automated products are found on the web sites http://cnrit.tamu.edu/ aflews and http://cnrit.tamu.edu/rsg/rainfall/rainfall.cgi, where daily deviations in forage production are computed along with daily satellite weather and dekadal NDVI or greenness data, processed by Texas A&M University Center for Natural Resource Information Technology and the Asociation for Strengthening Agricultural Research in East and Central Africa (ASARECA) Crisis Mitigation Office. To assist pastoralists in assessing the nutritional well-being of their free-ranging livestock, a series of fecal near-infrared reflectance spectroscopy (NIRS) nutritional profiling laboratories have been established in each country that allows extension or NGO personnel to determine how emerging conditions of the forage are impacting the performance of the animals. The fecal NIRS assessment provides an estimate of dietary crude protein (CP) and digestible organic matter (%), and a nutritional balance analysis (NUTBAL) model is used to predict changes in weight and body condition and help determine least-cost solutions to mediating

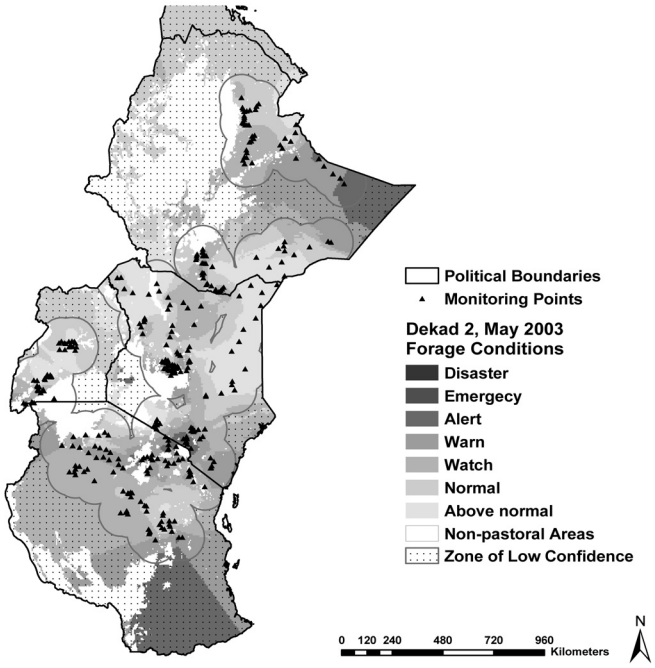
deficiencies where feedstuffs are available. A GLOBAL 2003 calibration equation emerged from this project allowing worldwide distribution of the system across Africa, South America, and other major livestock producing regions of the developing world.

Research

Activity One: Institutionalization Process for LEWS

Problem Statement. The primary problem addressed this past year was fully operationalizing rangeland/ livestock monitoring systems in each of the LEWS regions in Kenya, Uganda, Tanzania, and Ethiopia to initiate the institutionalization process, which will better support needs of early warning, relief and crisis mitigation agencies.

Figure 1 - Spatial extent of LEWS monitoring points and zones of computational confidence established in the past five years.



Approach. This past year was spent expanding LEWS monitoring sites and working with appropriate ministries, and agencies within those ministries, to effectively utilize the LEWS information output within their organization.

Progress. There were an additional 22 monitoring sites added in the Somali region of Ethiopia in collaboration with the Drought Preparedness and Prevention Commission (DPPC), Save the Children-UK, and Hope for the Horn (Figure 1). Eleven sites were recently set up across Southern Sudan by Dr. Gabriel Turacha of Vétérinaires Sans Frontieres (VSF)-Germany in coordination with the FAO-Food Security Assesment Unit (FSAU) office in Nairobi. Thirty sites have been established in Northwest Tanzania in collaboration with the Association for Strengthening Agricultural Research in Eastern and Central Africa-Animal Agriculture Research Network (ASARECA-AARNET). The total number of monitoring sites established in East Africa was 311. A major workshop was conducted with all relevant institutions in Ethiopia on the LEWS technology package, information acquisition, and report writing. DPPC will be the primary governmental organization within Ethiopia that will coordinate information flow with all the NGOs operating in the LEWS coverage areas of Eastern and Southern Ethiopia.

The Tanzania Minister of Water Development and Livestock allocated federal budget items for LEWS and has requested that LEWS zonal coordinators expand sites into the coastal region and southwestern Tanzania where pastoral cattle are also

located. LEWS is facilitating this process, helping with model tuning and servicing the model output back to the zonal coordinators.

In Kenya, the Ministry of Agriculture and Rural Development has split off the livestock program to a new Ministry of Livestock Development. We are in the process of moving the district reporting office and realigning the equipment for the new realities of this ministry. In Uganda, the Member of Parliament that heads the science and technology committee requested that we provide a plan for institutionalization beyond the National Agricultural Research Organization's (NARO) current LEWS system. Our LEWS coordinators are in discussion with him at this writing, working on modalities of funding and structure.

At the regional scale, a mechanism has been established where monthly "Greater Horn of Africa" Food Security Bulletins are issued, in which LEWS information is featured. This goes to over 400 people in key ministries, NGOs, and donor/relief organizations in East Africa. This is part of the International Governmental Authority on Drought and Development (IGADD) process and will eventually be taken over as the IGADD newsletter. The primary partners besides LEWS/GL-CRSP on this newsletter are FEWS NET, United States Geological Survey (USGS), World Food Programme (WFP), Drought Monitoring Center (DMC), Desert Locust Control Organization, Regional Center for Mapping of Resources for Development (RCMRD), and Kenya Met Office.

RANET (World Meteorological Organization system) and Arid Lands Information Network (ALIN) have stabilized the flow of information from the LEWS servers to their WorldSpace radio containers broadcasted to satellite radios scattered throughout the region. LEWS has helped establish 32 nodes but the number of total communication points is unknown as anyone with a WorldSpace radio and computer can receive these reports throughout Africa.

The backbone of this process is the agreement with the Center of Natural Resource Information Technology to maintain the LEWS server site and ensure that the computational and reporting capacity is maintained beyond the life of the project. This framework allows the host countries to focus their scarce resources on outreach and mitigation activities and, if they so desire, gradually evolve to take over the technical aspects of the automated computational system. Keeping this in mind, we have worked on several fronts to improve the data, the models, and the automation techniques. The following improvements were made in the last year:

1. The PHYGROW model's start/stop algorithm was reworked to allow faster load time between simulations. We improved the model's ability to handle temperature profiles of a species in a more dynamic manner.
2. The LEWS server was converted to a grid-computing environment linked to dual processor rack-mount computation servers to allow 20 PHYGROW simulations to run at the same time.
3. In an agreement with Dr. Chris Funk, University of California Santa Barbara and now FEWS NET/EROS, we were able to acquire the 1961 to 1996 Collaborative Historical African Rainfall Model (CHARM) rainfall data for the entire continent of Africa on a 11x11 km grid. We compared the CHARM data to the NOAA RFE rainfall data and purely generated rainfall data using the Weather Generator (WXGEN) for the Environmental Policy Integrated Climatic

model (EPIC) that was geo-corrected. We found that the CHARM data gave a greater match to the NOAA RFE rainfall data that we have used to drive our models since 1998; however, the yields were somewhat lower. We investigated the cause and found it to be related to the smoothing algorithm used where the 10-d dekadal data was distributed using a function that smoothes the distribution of values across all 10 days. The data lacked discontinuity of typical rainfall events and did not reflect dry-wet day proximities. Therefore, we looked at the World Meteorological Organization (WMO) weather generator coefficients for Africa and developed a surface spline of all 12 coefficients for each month. This database will be made available to the public soon. With each 11x11 km grid now capable of generating spatially explicit data, we ran 50-year simulations of weather in each grid. The CHARM data for each grid was paired with the WXGEN data for all 50 of the 10-d dekads. We designed a program that would find the dekad in the generator file that had the closest amount of rainfall. Then, the percent rainfall by day for the generator dekad would be multiplied by the CHARM summed decadal data to create a statistically more natural distribution of the rainfall. The corresponding daily minimum and maximum temperature and solar radiation from the generator were acquired to help build the complete weather file. These data now form the foundation data to drive the 311 PHYGROW runs for the LEWS sites and all deviations from normal forage standing crop generated from these event-corrected CHARM data. This is being made available to the public.

Demand for our web-based products included:

1. Situation reports distributed every ten days (http://cnrit.tamu.edu/aflews). The African LEWS website gets over 614 hits per day with 136.1 GB in 80 countries compared to 120 hits per day with only 2.1 GB of data download in 49 countries reported last year. Kenya remains the largest user in East Africa.
2. 39 MB of rainfall data downloaded from (http://cnrit.tamu.edu/rsg/rainfall/rainfall.cgi) in 27 countries this past fiscal year compared to 24 MB reported the prior fiscal year.

Activity Two: Spatial Extrapolation Technique Development

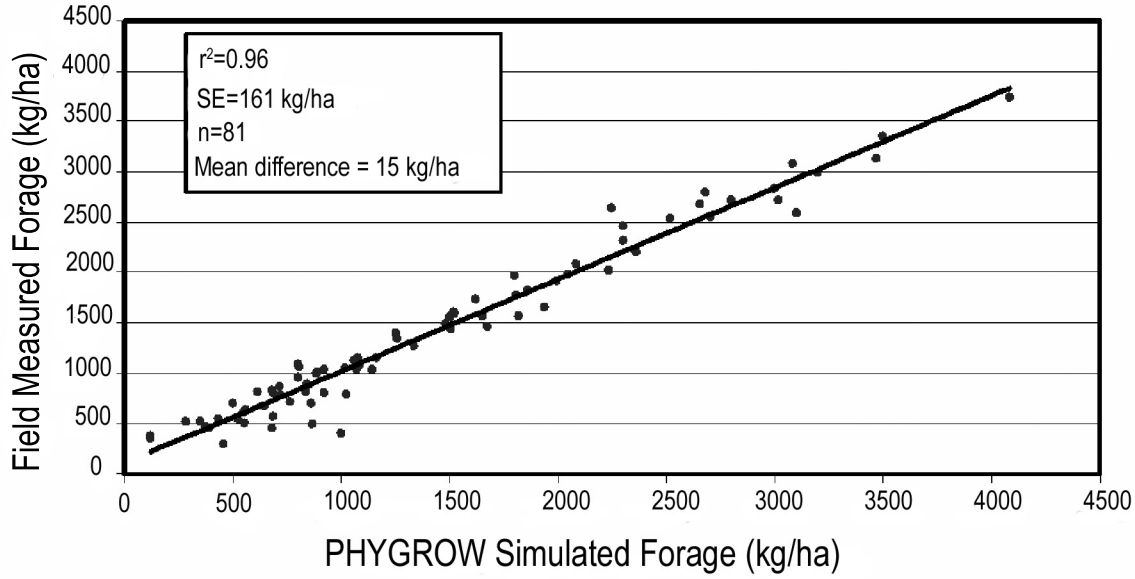
Problem Statement. The PHYGROW model forms the foundation of a toolkit used in the development of a Livestock Early Warning System in East Africa (LEWS) of the Global Livestock Collaborative Research Support Program (GL-CRSP). The system is used for monitoring the impact of emerging weather events on forage supply for livestock in the pastoral regions of East Africa. Primary inputs for the model include: soil parameters, plant community characteristics, and livestock management decision rules, which are driven by satellite-based gridded weather data for a particular location to simulate daily forage available for livestock and wildlife. LEWS has created a new range of forage monitoring products, expected to complement the existing early warning systems in East Africa to aid in the decision-making process, particularly in the pastoral regions. Regular verifications are conducted to demonstrate that the model simulation output of the available forage agrees with observations in the field and to ensure that the input parameters and logical structure of the model are correctly represented.

Approach. Over the past 18 months, the LEWS zonal teams selected 81 sites across the region for intensive sampling with 22 sites measured in this past year. Fifty 0.5 m^2 quadrats were sampled for each monitoring site representing the 11 x 11 km grid using a comparative yield method, where forage biomass is visually estimated on all quadrats using a ranking method and only 15 quadrats were clipped and estimated to develop a regression equation (Haddock and Shaw 1975). The regression equation is used to convert the rankings into actual forage values. Since PHYGROW estimates grazed forage for each of the target herbivores, only forage available to livestock was measured in the field. The fifty quadrats were distributed along five transects, located across the selected grid for verification. The sites were re-sampled if the field sampler's visual estimate and associated clipped samples resulted in r^2 values less than 0.80. More training was provided to the field enumerators having difficulty estimating standing forage values. Simple linear regression was used as a test for the relationship between sampled forage on offer and PHYGROW-simulated total available forage for a target livestock species. Only herbaceous species were used for this analysis.

Progress. As indicated in the earlier section, we were able to add 22 new monitoring sites in Eastern Ethiopia that greatly expanded our ability to cover much of the Somali and Afar region of Ethiopia. We completed our final series of verification of the LEWS predictions of standing crop. Using the PHYGROW model as a point sample linked with satellite weather has proven effective with an R^2= 0.96 and SEP= 161 kg/ha (Figure 2). Final sets of verification studies are currently underway in the region by LEWS zonal coordinators.

One of the major challenges that we faced this past year was converting point based 90-d forage forecasts from the 300+ points into a regional map. The event-corrected CHARM rainfall data that was generated allowed us to have a much more robust forecasting analysis since the rainfall behaved more like real rainfall in the PHYGROW model and allowed

Figure 2 - Relationship between PHYGROW-simulated forage and actual field measurements across East Africa.



greater synchronization with the historical 10-day NDVI values starting in 1981 to present. The problem was determining how to continue the forage forecast with corresponding NDVI data for the 90-day forecast. We finally developed a pattern matching approach where the 300+ LEWS monitoring points were statistically compared with the dekadal record of NDVI data and those historical images with the highest spatial match provided a mechanism to co-krig future forage conditions 60-d out from the current conditions. We are now in discussions with the International Research Institute for Climate Prediction at Columbia University (ref. Dr. Maxx Dilley) to coordinate our forecasting technique with their emerging NDVI forecasting methodology. Currently, they feel comfortable with a 90-d forecast but have a goal for a 180-d forecast. This component of our work will be continued in the upcoming Livestock Infomation Network and Knowledge System (LINKS) project as it is critical for us to be able to predict likely outbreaks of Rift Valley Fever relative to livestock movement patterns and potential livestock market volumes in the region.

We have established the MAPSERVER program on the http://cnrit.tamu.edu/aflews web site with all the major land and program features that allows users to build their own maps with customized features. All of the LEWS data system will be moved over to this data structure to allow greater coupling of activities in LINKS with the LEWS analysis. The geo-spatial techniques have been well accepted in the development community. Through diligent efforts by Dr. Demment, the LEWS technology package was provided the opportunity to be showcased at the Ministerial Conference and Expo on Agricultural Science and Technology Conference in Sacramento, California. The conference was sponsored by the U.S. Department of Agriculture (USDA), the U.S. Agency for International Development (USAID), and the U.S. Department of State.

Over 45 agricultural ministers attended the briefing made by Dr. Stuth and personal briefings provided by Drs. Stuth and Kaitho to the Ministers of Agriculture from Kenya, Tanzania, Uganda, Rwanda, Cameroon, Sri Lanka, South Africa, Swaziland, Botswana, Senegal, Djibouti, Mali, and Honduras.

Activity Three: Enhanced Effectiveness of NIRS Fecal Profiling Monitoring Technology to Improve Livestock Management in East Africa

Problem Statement. The primary problem addressed with this activity was establishing regional analytical capacity to utilize NIRS technology for nutritional management of livestock in East Africa. The capacity in the region to address nutritional issues of free-ranging livestock has been established in all LEWS countries. The development and deployment of a more robust calibration equation in the region would improve the capacity of NARS and extension personnel to support nutritional profiling of livestock in pastoral regions.

Approach. All of the LEWS diet:fecal pairs generated in Ethiopia, Uganda, Kenya, and Tanzania were combined from research conducted in Ghana by a World Bank-funded Ph.D. student, International Livestock Research Institute (ILRI) projects in Nigeria, Niger, and Ethiopia, and projects in Australia, Argentina, Canada, and the U.S. to form a global calibration equation for cattle, sheep, and goats. The diet:fecal pairs were subjected to modified partial least squares analysis using the WinISI (Inservice Inspection) software.

Progress. All NIRS laboratories were

established on schedule for each of the four countries. We were able to send the Tanzanian staff to Sweden for training by First in Food Analysis (FOSS) International staff. This was fully paid for by FOSS. We also provided training to the Ethiopian lab and numerous other scientists interested in NIRS technology at a 3-day workshop sponsored by ILRI in Addis.

Given the scope of experiments conducted in LEWS, the diet:fecal pairs created in East Africa were added to the GANLAB Global Equation and are currently being transferred back to all the labs created in East Africa. Since all the NIRS machines are calibrated to the Texas A&M machine, all advances made by the Grazingland Animal Nutrition Laboratory (GANLAB) can be directly transferred to the labs in East Africa with a simple email attachment. Any lab in the region can transfer their samples or equations by email between labs as well. The GLOBAL 2003 calibration equation statistics for cattle, sheep, and goats from samples created in the USA, Canada, Australia, Argentina, Nigeria, Niger, Ghana, Ethiopia, Kenya, Uganda, and Tanzania are presented in Table 1.

One of the critical components of the NIRS system is the NUTBAL PRO software that is used to translate the NIRS diet quality predictions into animal performance. Recent observations of young livestock on sub-maintenance diets in East Africa, South America, and West Texas have indicated that protein requirements and basal metabolism are altered, requiring an adjustment to the NUTBAL nutritional requirement and gain/loss functions. Also, overly fat dry open cows were being overpredicted in performance and we had to search the literature and make adjustments to gain efficiency as a function of body condition and the ratio of energy to protein in the diet. Both of these adjustments have allowed NUTBAL PRO to be one the most rigorously tested nutritional software packages under real-world conditions and suitable for use in tropical Africa.

Table 1 - NIRS fecal profiling calibration statistics for the new GLOBAL 2003 prediction of crude protein (CP) and digestible organic matter (DOM) in cattle, sheep, and goats.

Species/Nutrient	N	R^2	SEC
Cattle			
CP	953	0.95	0.87
DOM	794	0.91	1.51
Goats			
CP	214	0.99	0.53
DOM	213	0.94	1.46
Sheep			
CP	337	0.95	0.98
DOM	213	0.94	1.46

We had indicated in our prior workplans that we would start a student to develop a NIRS fecal calibration equation to predict diet protein and digestibility of donkeys in Africa. The LEWS component in Ethiopia had identified this need but failed to recruit a student and organize the research. Therefore, when the University of Asmara indicated that the Netherlands Organization for International Cooperation in Higher Education (NUFFIC) would fund a Ph.D. student, Negusse Kadine, to train in the application of NIRS technology for rangeland animal management, we accepted him into the Department of Rangeland Ecology and Management at Texas A&M University (TAMU).

Mr. Kadine then organized and conducted a stall-feeding trial where ten donkeys were fed 100 different mixed rations of natural forages and crop residues commonly found in East Africa (the research was conducted at the Equine Research Center at TAMU). This study has been completed. Fecal NIRS can be used to determine crude protein (CP) and digestible organic matter (DOM) of donkeys.

Calibration statistics for CP were R^2 =0.96, SEP=0.77, and DOM R^2=0.92, SEP=1.75. *In vivo* digestibility was derived from 4-d, 24-hour a day total fecal collections. While CP was determined by the Hack method to derive ort adjusted, whole-diet values. The Mpala Research Center (MRC) in Laikipia District of Kenya has just shipped common forages available to donkeys and zebra to the Kenya Agricultural Research Institute (KARI) research center at Naivasha to conduct a mirror study in East Africa. MRC is most interested in determining if the donkey fecal profiling technology can be used to determine the diet quality of free-ranging zebra. KARI staff are currently conducting the experiment at Naivasha and will scan the samples and conduct the *in vivo* DOM analysis, wet chemistry for CP and P, and then transfer the spectra and lab results to the U.S. for analysis with the U.S.-derived samples. As part of Mr. Kadine's Ph.D. program specified by NUFFIC, he is reviewing the nutritional requirements and gain prediction code of the NUTBAL goat component and conducting a weight performance trial to test the current performance algorithms in the model. The final phase of his dissertation research will focus on testing the final system in Eritrea in 2004.

Table 2 - Household statistics and gender composition of the drought perception survey, conducted in pastoral communities of Kenya, Tanzania, and Uganda.

	Kenya	Tanzania	Uganda
Total Number of People Surveyed	338	246	86
Percent Female	47.3%	13.8%	11.6%
Percent Male	52.7%	86.2%	88.4%

Activity Four: Institutional Capacity Building

Problem Statement. The primary issue facing LEWS during this final year of the program was to build the skills of the technical support staff in the use of the LEWS toolkit for active monitoring and decision-making in national Emergency Warning System agencies, IGAD and FEWS NET, and critical NGOs. It is imperative to leave a network of skilled personnel in key organizations to ensure that the technology can be moved forward by the respective organizations. However, we need to determine an effective way of organizing the information interpretation and delivery process.

Approach. As outlined earlier, we have established a mechanism for institutions in East Africa to acquire, interpret, and distribute information from LEWS. Over 400 key decision-makers in East Africa get the LEWS reports. A monthly newsletter on conditions in East Africa is distributed to key government offices and reports are provided to over 30 NGO communication nodes in the region. We have conducted workshops on the LEWS system with key entities in Ethiopia, Kenya, and Tanzania. To gain a better understanding of the effectiveness of the current institutional outreach activities, we conducted a pastoral community survey during the past year of 26 pastoral communities involving 607 heads of pastoral households.

Progress. ***LEWS Pastoral Perception Survey.*** The community surveys indicated that 23.9% of heads of households in these 26 pastoral communities were aware of LEWS, and when linked with our communication nodes, zone of coverage, and prior coping mechanism survey statistics conducted by LEWS and ASARECA, over 114,000 households and 2 million people are influenced

Table 3 - Composition of the communities surveyed in Kenya, Tanzania, and Uganda.

Country	% Pastoralists	% Agropastoralists	% Other
Kenya	76.5%	22.7%	0.8%
Tanzania	63.1%	36.9%	0.0%
Uganda	6.6%	92.2%	1.2%

by LEWS outreach activities, impacting 1.4 million km^2 of rangeland, 40 million cattle, 30 million sheep, and 32 million goats. The primary goal of the survey was to determine what pastoral communities perceived as a "deviation from normal" forage conditions relative to the LEWS computations of forage supply, forage deviation, forage percentile ranking, and NDVI. The main objectives were to determine how the current LEWS analysis tracks the pastoral decision process to move livestock in reaction to drought, and to provide a basis for the refinement and improvement of communication strategies for the dissemination of LEWS information and technological outputs.

Overall, 30.1% of the people surveyed in East Africa were women and 69.1% were men (Table 2). Pastoralists comprise about 48.7% of the people surveyed in East Africa (Table 3). The remainder consists of predominantly agro-pastoralists (50.6%). Only 0.7% were pure farmers and ranchers. The communities interviewed were predominantly pure pastoralists in Kenya and Tanzania and agropastoralists in Uganda.

The communities interviewed were asked to suggest places where LEWS information could be placed. Community leaders and extension and village government offices were most frequently mentioned. About 23% of the respondents suggested a Chief's residence as the most suitable home for LEWS information, citing the easy access of information to all community members. They felt that the best way to deliver the information would be through the chiefs, with assistance from local extension agents in the oral explanation and interpretation of the LEWS information for their respective communities.

An equal number of respondents (23%) chose extension offices as the ideal place for LEWS information, citing the fact that many extension agents live within those communities. Extension agents in those areas also serve as community site monitors, and would ensure that the information reaches the community, and that the products are explained and interpreted for the community. Throughout all the interviews, it was evident that the communities have a great respect for the extension agents.

Village government offices, community centers, and district agricultural and veterinary offices were also widely mentioned as central locations for the placement of LEWS information. Common to all these offices is the fact they each work closely with the pastoral communities and have developed their own unique methods of communication with them.

The majority of the respondents indicated that they needed more time to evaluate LEWS information for the following reasons:

1. They needed time to build confidence in LEWS outputs relative to events they can observe.
2. They needed more time to evaluate LEWS outputs in relation to current weather patterns that seem to have been changing drastically in recent years.

However, most of these communities indicated that the LEWS information is potentially useful in showing where there is available forage so they could explore alternative forage

resources in a timely manner. They also expressed an interest to get the information on a regular basis. There was a consistent suggestion that including livestock market prices would add value to the LEWS reports. Actions taken by those influenced by LEWS information included:

1. Moved livestock.
2. Moved the livestock and contemplated selling some of the animals but didn't do so because it rained soon afterwards.
3. Sold livestock.
4. Sought permits to move and stock routes.
5. Sent young men for reconnaissance.
6. Avoided burning grass and cleaned wells and dams.

Southern Kenya LEWS Community Outreach Pilot Site. The community communication survey carried out early in the year 2003 indicated that all communities desire to have the LEWS forage prediction outputs every month. In addition, the information is to be communicated to these communities through the existing project Site Monitors or another government officer, preferably one that is involved in livestock extension service. Following up on these findings, two of the existing monitoring sites were selected for pilot test runs to discover the effectiveness of the information flow and its reception by the communities. The communities selected were Mbirikani and Magadi, both in Kajiado. Initial community meetings were convened by the project's zonal coordinator at each location, together with the extension service providers and the site monitors where:

1. First, the subject of forage availability and adequacy was introduced.
2. The community's perceptions were captured through a facilitated discussion and the consensus written down and mounted in a convenient place for everybody in attendance to see.
3. This was followed by a display of the LEWS output, highlighting the contrasts and similarities as applicable.
4. The forage deviation trend lines developed by the communities earlier were revisited. Through consensus, appropriate adjustments were made on the basis of prevailing weather conditions.
5. Lastly, follow-up meetings were agreed upon. In the subsequent months, the site monitors were given the outputs to take to the communities.

In addition, a discussion was held in June in Magadi with some of the community members during a site verification exercise within the Olkramatian Group Ranch. They expressed surprise at how the LEWS predictions were closer to the emerging forage situation than their own estimates. Before the long rains, the Magadi community had feared that a small lake known as Kabongo would dry up and if that were to happen, then massive livestock losses would be experienced. Whereas they had foreseen a great deficit because the long rains had been delayed, there was instead plenty of pasture and any livestock movements were mainly to take advantage of quality rather than search for quantity.

Similarly, the community at Mbirikani had expected a bounty of forage because the long rains had not only come on time, but they had come from the direction usually associated with good rains. At that time however, PHYGROW showed a possible drop in forage below normal. In subsequent months, it turned out that actually forage was below normal.

The site in Mbirikani, a Group Ranch, has been considered ideal for this project because the management committee is very strong and is able to make and enforce decisions on pasture utilization. However, when droughts

become as frequent, as they have been in recent years, their authority is undermined because the basis for decision-making is weakened. Herds then move anywhere for survival. The rich, who can afford to transport water, move their livestock closer to the Kyulu hills while the rest move out of the ranch in various directions. In both scenarios, an element of changing weather patterns seems to be in play, thus making traditional indicators less reliable. Plant and spatial indicators, for instance, seem to be affected most.

In all areas, monthly follow-ups are necessary to build community confidence in the outputs, which are on the right track so far. The process, however, should also be institutionalized at the local level so that communities can continuously get this information. The major worry has been sustainability – will the LEWS outputs be available beyond the project's life? Pastoralists and other stakeholders express concern that since PHYGROW analysis, based at Texas A&M University, is controlled by foreigners, its future as a tool for sustained use locally is doubtful. Therefore, government commitments to building mirrored capacity will need to be a priority in the future, even though the system is quite stable for the foreseeable future, and Texas A&M University has made a long-term commitment to maintaining the system indefinitely.

Capacity Building Workshop. A capacity building workshop on Livestock Early Warning Tools was organized by LEWS for the Early Warning Department (EWD) of the Disaster Prevention and Preparedness Commission of Ethiopia (DPPC) and Allied Institutions on February 10 – 20, 2003 at Nazareth, Ethiopia. The workshop, fully sponsored by the GL-CRSP, was administered by LEWS.

The National Disaster Prevention and Preparedness Committee (NDPPC) of Ethiopia is responsible for the overall decision-making on all matters related to disaster prevention and management. The EWD takes the lead in the development of improved procedures for regular data collection, analysis, and dissemination at the national level. The EWD has put in place four different teams to carry out the above noted activities. These are:

1. Crop monitoring team
2. Market and pastoral surveillance team
3. Documentation team
4. Field surveillance team

The workshop was an attempt to improve the efficiency of institutions involved in early warning to implement a timely detection and declaration of a disaster in the pastoral regions of Ethiopia. The poor infrastructure in these regions is a major obstacle to timely monitoring of the livelihood of pastoral communities and dissemination and communication of early warning reports to the decision-makers and users; as a result, the reporting of early warning information has not been effective in the pastoral areas of the country. The reporting systems used by the different organizations involved in early warning are not uniformly deployed. Therefore, there is an urgent need for improvement in communication facilities like telephone, radio, internet, and fax machines in key areas in the pastoral regions.

The workshop brought together 14 participants representing various agencies involved in early warning and food security issues in the pastoral regions of Ethiopia, including DPPC, Disaster Prevention and Preparedness Bureaus (DPPB) for the pastoral regions of Ethiopia (Oromia, Somali, Afar and Southern Nations, Nationalities and Peoples), and non-governmental organizations (Save the

Children-United Kingdom and Hope for the Horn), and the Ethiopian Agricultural Research Organization. The objectives of the workshop were to:

1. Bring together agencies involved in early warning and food security issues in the pastoral regions of Ethiopia in order to compare their approaches, methods, and experiences.
2. Present the latest scientific information on the LEWS technology and reporting system with regard to forage monitoring and 90-day projections employed as an early warning tool.
3. Discuss ways of tailoring LEWS analysis and reports to suit the overall early warning information needs in Ethiopia and to identify information and delivery gaps.

Human Resource Development. The LEWS project has had a tremendous impact on NARS and NGOs working in the region. The workshop and subsequent joint field exercise with key NGOs and DPPC in Ethiopia greatly expanded the LEWS human resource network. We have summarized that network below to demonstrate the depth and breadth of impact on human capacity building in the region.

LEWS/GL-CRSP Program, Central Tanzania

Country	Zone	Name	Position/Institution	Gender
Tanzania	Central	Angello J. Mwilawa	Zonal Coordinator	Male
Tanzania	Central	Ezekiel H. Goromela	Assistant Zonal Coordinator	Male
Tanzania	Central	Rashid S. Kidunda	Sokoine University	Male
Tanzania	Central	Vitalis Temu	Livestock Research Officer	Male
Tanzania	Central	Christopher Ulime	Senior Livestock Field Officer	Male
Tanzania	Central	C.M. Shayo	Head of NIRS laboratory	Male
Tanzania	Central	Coletha Ngwando	NIRS laboratory technician	Female
Tanzania	Central	Mary Dgodath Ngowi	NIRS laboratory technician	Female
Tanzania	Central	S.N. Mniko	RLA-DODOMA	Male
Tanzania	Central	Urassa R.	DALDO-MPWAPWA	Male
Tanzania	Central	E.L. Ollomi	RLA-SINGIDA	Male
Tanzania	Central	Mwachambi	DALDO–DODOMA	Male
Tanzania	Central	Kasanga	DALDO–KONGWA	Male
Tanzania	Central	S. Mtalo	DALDO–MANYONI	Male
Tanzania	Central	Karigo	DALDO–SINGIDA	Male
Tanzania	Central	Antalo	DALDO–KONDOA	Male
Tanzania	Central	Manetho	DALDO–KILOSA	Male
Tanzania	Central	J.E. Mghwira	Officer-in-charge-Mpwapwa	Male
Tanzania	Central	E.N. Pallangyo	RAA-Dodoma	Male
Tanzania	Central	Musa Midugu	RAA-SINGIDA	Male

LEWS/GL-CRSP Program, Northern Tanzania

Country	Zone	Name	Position/Institution	Gender
Tanzania	Northern	Margaret Nana Kingamkono	SARI, Arusha	Female
Tanzania	Northern	R.N. Mero	SARI, Arusha	Male
Tanzania	Northern	Phillemon Mushi	SARI, Arusha	Male
Tanzania	Northern	Marietha Z.Owenya	SARI	Female
Tanzania	Northern	Ndeshi S. Munisi	SARI	Female
Tanzania	Northern	Marcelina Minja	SARI	Female
Tanzania	Northern	N.F.Massawe	Research Coordinator, SARI	Male
Tanzania	Northern	R.Mtae,	TLTI, Arusha	Male
Tanzania	Northern	G. Ngwijo	DALDO, Monduli	Male
Tanzania	Northern	Elias Kea	DALDO	Male
Tanzania	Northern	David Chalamira	DALDO	Male
Tanzania	Northern	Martin Halid	DALDO	Male
Tanzania	Northern	Reginald Swai	DALDO	Male
Tanzania	Northern	Enrisha Msangi	DALDO	Male
Tanzania	Northern	Saideiya P.	DALDO	Male
Tanzania	Northern	Gillead Mtui	DALDO	Male
Tanzania	Northern	Richard Semwenda	DALDO	Male
Tanzania	Northern	Alijumaa Mkumbwa	DALDO	Male
Tanzania	Northern	Muze Msangi	DALDO	Male
Tanzania	Northern	Arnod Massawe	DALDO	Male
Tanzania	Northern	E.N. Ole Wavii	DALDO-Simanjiro	Male
Tanzania	Northern	Dr. F. Matunda,	DALDO-Mwanga	Male
Tanzania	Northern	N.S.Mollel	DALDO-Kiteto	Male
Tanzania	Northern	Dr. E.P.Osanga	DALDO-Same	Male
Tanzania	Northern	Dr. Rwegasira	DALDO-Monduli	Male
Tanzania	Northern	Dr. Uroni	DALDO-Babati	Male
Tanzania	Northern	B.M. Mwawado	DALDO-Karatu	Female
Tanzania	Northern	Dr. Uliky	DALDO-Hai	Male
Tanzania	Northern	Dr. Tigwela	DALDO-Mbulu	Male
Tanzania	Northern	Mr. Simon Soinda	Ngorongoro District Council	Male
Tanzania	Northern	S.A. Msuya	Mwanga District	Male
Tanzania	Northern	Mr. Lucas Ole Mukusi	Simanjiro District	Male
Tanzania	Northern	Mr. Bakari Lukuni	Same District	Male
Tanzania	Northern	Mr. Gabriel Bukhay	Babati District	Male
Tanzania	Northern	Mr. Leonard Ulotu	Hai District	Male
Tanzania	Northern	Mr. Isaac Bayo	Mbulu District	Male
Tanzania	Northern	Mr. Lembile S.Kone	Kiteto District	Male
Tanzania	Northern	Wilson Rutta	WORLD VISION, Arusha	Male
Tanzania	Northern	Gaspar Leboi	ERETO Pastoralist Council	Male
Tanzania	Northern	Helen Nguya	AIDRO, Arusha	Female
Tanzania	Northern	Martin Ole Saning'o	ILARAMATAK LORKONEREI, Arusha	Male

LEWS/GL-CRSP Program, Laikipia Zone, Kenya

Country	Zone	Name	Position/Institution	Gender
Kenya	Laikipia Zone	Zola Gibson	Laikipia Zonal Coordinator	Female
Kenya	Laikipia Zone	James Legei	Program Manager, OSILIGI	Male
Kenya	Laikipia Zone	Nick Gerogiadis	Mpala Research Center	Male
Kenya	Laikipia Zone	Claus Mortensen	Mugie Ranch	Male
Kenya	Laikipia Zone	Fred Lesakale	Wamba Community Development Program	Male
Kenya	Laikipia Zone	Michael	SARDP	Male
Kenya	Laikipia Zone	Abdi	SARDP	Male
Kenya	Laikipia Zone	Eric	Loisaba Koija	Male
Kenya	Laikipia Zone	Barnabas Ekeran	Laikipia Wildlife Forum, Rumuruti	Male
Kenya	Laikipia Zone	Daniel Lomoe	Laikipia Wildlife Forum, Luoniek	Male
Kenya	Laikipia Zone	Morias Kisio	Laikipia Wildlife Forum	Male
Kenya	Laikipia Zone	Joseph Lomart	TUKASOMA	Male
Kenya	Laikipia Zone	Philip Valentine	Segera Ranch	Male
Kenya	Laikipia Zone	Wellington Okieno	WorldVision Kenya	Male

LEWS/GL-CRSP Program, Southern Kenya Zone

Country	Zone	Name	Position/Institution	Gender
Kenya	Southern	William Ngoyawu Mnene	LEWS/GL-CRSP Country Coordinator	Male
Kenya	Southern	Elizabeth Nduku Muthiani	Zonal Coordinator, South Kenya	Female
Kenya	Southern	Mr. Otieno	District Range Officer	Male
Kenya	Southern	Mr. Mwangi	District Livestock Production Officer	Male
Kenya	Southern	Jackson Wandera	SARDP, Kajiado	Male
Kenya	Southern	Mr. Sindyo	Game Warden, Kajiado	Male
Kenya	Southern	Mr. Mbuvi	District Livestock Production Officer, Makueni District	Male
Kenya	Southern	Michael Kiteng'e	Divisional Extension Coordinator, Makindu	Male
Kenya	Southern	Jeremiah M. Ngaya	Makindu Site, Makueni District	Male
Kenya	Southern	Mr. Maina	Assist. Site Monitor, Kasigau	Male
Kenya	Southern	F. Kiungu	Site Monitor, Kasigau	Male
Kenya	Southern	James N. Ituli	Technical Assistant, KARI Kiboko	Male
Kenya	Southern	Antony Mosu	Technical Assistant, KARI Kiboko	Male
Kenya	Southern	Robert Ngetich	Technical Assistant, KARI Kiboko	Male
Kenya	Southern	Charles Konde	Laboratory Technician, KARI Kiboko	Male
Kenya	Southern	Peter Mweki	Lab Technologist, KARI Kiboko	Male
Kenya	Southern	K. Mwaniki	Livestock Extension Officer, Makueni District	Female
Kenya	Southern	J.N. Mwanjewe	District Range Officer, Taita/Taveta	Male
Kenya	Southern	R. Mjomba	Ranch Manager, Kasigau	Male
Kenya	Southern	Francis Kunyanga	Site Monitor, Divisional Extension Coordinator, Magadi	Male
Kenya	Southern	Stanley Oloiputar	Site Monitor at Mbirikani, Assistant Range Officer, Kajiado	Male

LEWS/GL-CRSP Program, Northwest Zone Turkana District, Kenya

Country	Zone	Name	Position/Institution	Gender
Kenya	Northwest	Jane Jepchirchir Sawe	Egerton University	Female
Kenya	Northwest	James Eyapan	ALRMP, Lodwar	Male
Kenya	Northwest	Christopher Ajele	Ministry of Agriculture, Lodwar	Male
Kenya	Northwest	Gollo Guracho Kumbi	World Food Program, Nairobi	Male
Kenya	Northwest	Chris Erukudi	WORLD VISION, Lodwar	Male
Kenya	Northwest	Darlington Akabwai	CAPE UNIT - OAU IBAR	Male
Kenya	Northwest	Allyce Kureya	SNV, NDO, Nairobi	Female
Kenya	Northwest	Maria Twerda	NV, NDO, Lodwar	Female
Kenya	Northwest	Mbithi Mutungi	CAPE, Lodwar	Male
Kenya	Northwest	Eris J.B. Lothike	OXFAM, Lodwar	Male

LEWS/GL-CRSP Program, Northern Zone (Marsabit), Kenya

Country	Zone	Name	Position/Institution	Gender
Kenya	Northern	Joseph Njoroge Ndung'u	KARI Marsabit	Male
Kenya	Northern	Aphaxard J. N. Ndathi	Marsabit	Male
Kenya	Northern	George A. Keya	Director, KARI Marsabit	Male
Kenya	Northern	M. B. Halake	Coordinator ALRMP, Marsabit	Male
Kenya	Northern	Alex Ali Guleid	MOARD, Marsabit	Male
Kenya	Northern	Chachu Tadicha	Coordinator CIFA, Marsabit	Male
Kenya	Northern	Simon Munyao	Coordinator ITDG, East Africa	Male
Kenya	Northern	Sora Adano	Project Manager, CEC, Marsabit	Male
Kenya	Northern	Alfred Ngonze	KWS	Male
Kenya	Northern	Huka Duba	Food for the Hungry International, Marsabit	Male
Kenya	Northern	Bernard Wafula	MOARD, Isiolo	Male
Kenya	Northern	A. A. Ali	ENNDA, Isiolo	Male

LEWS/GL-CRSP Program, Southern Zone (Borana), Ethiopia

Country	Zone	Name	Position/Institution	Gender
Ethiopia	Southern	Ato Assefa	Adami Tulu Research Institute	Male
Ethiopia	Southern	Alemu Adare	SORDU, Yabello	Male
Ethiopia	Southern	Bayissa Hatewu	EARO Holetta	Male
Ethiopia	Southern	Amsalu Sisay	Adami Tulu Center	Male
Ethiopia	Southern	Abdissa Abalti	Adami Tulu Center	Male
Ethiopia	Southern	Ashenafi Mengistu	Adami Tulu Center	Male
Ethiopia	Southern	Daniel Molla	FEWS NET	Male
Ethiopia	Southern	Teshome Erkineh	Early Warning Dept., DPPC	Male
Ethiopia	Southern	Beletu Tefera	Early Warning Dept., DPPC	Female
Ethiopia	Southern	Zinash Sileshi	EARO	Female
Ethiopia	Southern	Getachew Haile	OARI	Male
Ethiopia	Southern	Dubale Adamasu	Farm Africa	Male
Ethiopia	Southern	Suleiman S. Mohamed	SCF-UK	Male

LEWS/GL-CRSP Program, Uganda

Country	Zone	Name	Position/Institution	Gender
Uganda	Central/S.Western	Cyprian Ebong	NARO	Male
Uganda	Central/S.Western	Felix Bareeba	Makerere University	Male
Uganda	Central/S.Western	Rose Omaria	NARO	Female
Uganda	Central/S.Western	Steven Byenkya	NARO	Male
Uganda	Central/S.Western	Grace Ebiyau	NARO	Female
Uganda	Central/S.Western	Charles Sudhe	NARO	Male
Uganda	Central/S.Western	Everlyn Komutunga	NARO/Agro-Meteorology	Female
Uganda	Central	Kitaka, G.	Veterinary Officer, Nakasongola	Male
Uganda	Central	Eswagu, J.	Site Monitor, Wabinyonyi	Male
Uganda	Central	Sekatte, J.	Site Monitor, Nabiswera	Male
Uganda	Central	Bugeza, J.	Site Monitor, Lwampanga S	Male
Uganda	S.Western	Kawooya, E.	Veterinary Officer, Sembabule	Male
Uganda	S.Western	Lule, G.	Site Monitor, Lugusuru	Male
Uganda	S.Western	Kakoza, U.	Site Monitor, Ntusi	Male
Uganda	S.Western	Barigye, J.	Veterinary Officer, Mbarara	Male
Uganda	S.Western	Bagatuzayo, W.	Site Monitor, Kanyaryeru	Male
Uganda	S.Western	Kitimbo, J.	Site Monitor, Kikaatsi	Male
Uganda	S.Western	Aziku, L.	Site Monitor, Isingiro	Male
Uganda	Central/S.Western	William Olaho-Mukani	MAAIF	Male
Uganda	Central/S.Western	A. Hakuza	MAAIF	Female
Uganda	Central/S.Western	Majugu, A.W.	Department of Meteorology	Male
Uganda	Central/S.Western	Mwesigwa Shem	Ministry of Disaster Preparedness	Male
Uganda	S.Western	Dr. Musinguzi	GTZ Pastoral Development Project	Male
Uganda	Central/S.Western	Andrew Mutengu	FEWS NET	Male
Uganda	Central/S.Western	Agnes Atyang	FEWS NET	Female
Uganda	S.Western	Mr. Rusoke	ULAMP	Male
Uganda	Karamoja	Michael Oyet	Oxfarm GB	Male
Uganda	Karamoja	Alinga Hellen	Karamoja Agro-pastoral Development Project	Female

Activity Five: Pastoral Livestock Marketing in Northern Kenya and Southern Ethiopia (joint with the PARIMA project)

Problem Statement. The main issue in this activity was the need to identify priority interventions to promote more timely livestock sales in relation to stress periods. The role of LEWS was to organize information into a spatial context and initiate first order movement and a marketing model using the results generated by PARIMA on ground analysis.

Approach. This past year represents the last year of a three-year collaboration between the PARIMA group and LEWS, with primary participants including Drs. Chris Barrett, Peter Little and Jerry Stuth. Laban Macopiyo, a Ph.D. student at TAMU from Kenya, was partially funded by this component to work with the outcome of the surveys and analysis conducted by Drs. Barrett and Little on market issues and intervention constraints, with a goal of helping to construct an agent-based livestock movement and marketing model. The reader is referred to the PARIMA section of the annual report to see the findings of the surveys. This report focuses on the model development issues.

Progress. ***Model Structure.*** The model has been developed using both geographic-information-systems (GIS) and agent-based modeling under the Java environment. A planned publication will provide detailed descriptions of how these environments have been integrated. ArcGIS 8.2 GIS was used to develop and process initialization maps. Map analysis and output display has been carried out in the Java development and deployment environment. The Java environment was also used to develop an agent-based decision environment and used to conduct simulations in which independent agents (i.e., individual cattle herds & herders) interacted with one another and the environment in space and time. During a simulation, each agent developed a unique history according to the rules assigned to its type of object. The agent-based model consisted of an observer interface (interface control, display-animation, and time schedule) and a model environment (equations describing ecological and behavioral features of modeled agents). Simulations were conducted locally via command-line statements but are eventually targeted to be run remotely via a web-based interface.

Interactions between the modeled agents and their environment across the Eastern African landscape and surrounding areas were simulated. The total area modeled was 580 km x 580 km. Using a daily time step, the model simulated interactions among agents over a 150-day period (plans are underway to extend this), representing the migration season of the pastoralists in the region.

Livestock Movement Patterns. Our first objective was to develop a model capable of simulating the daily movements of livestock herders and their cattle as they travel from the homefront locations to foraging areas. By identifying feeding areas frequently visited by the livestock for a given landscape as well as patterns of large-scale movements of pastoral livestock, it is hoped that results of this modeling effort could be used by policy managers to predict and focus intervention efforts in times of drought, disease outbreaks, source of cattle market supplies, conflict, etc. Although the primary interest was livestock movement, these movements were a function of the movements of the pastoralist, which in turn is a function of the physical characteristics of the available feeding areas, available forage, conflict, cultural practices etc. Therefore, the dynamics and interactions between the agents and their environment was simulated. The focus was on dynamics that occur within the seasonal movement of the livestock, and also seasonal and annual changes in variables such as habitat quality, number of livestock, seasonal trigger for new movement, and ethnic territorial and land use limitations.

Feeding Areas. This object type was created to represent physical locations on the landscape. While feeding areas remained stationary, their attributes were dynamic. Feeding areas maintained information about the grazing suitability of a given location for cattle, distances among feeding areas, and the presence of other agents (i.e., consumption by other cattle herds, etc.).

A feeding area represented an 11 km by 11 km area on the landscape, and was considered to be homogenous with regard to all attributes throughout this area. For example, the grazing suitability for cattle across the entire 11 km square area was represented as an attribute of a single feeding area. This approach was used so that landscape-level features could be captured without the necessity of having detailed knowledge of microhabitat characteristics within an 11 km cell (work is underway to reduce this cell resolution as new data becomes available). Furthermore, this spatial scale

approximates the level of detail needed to simulate the relatively long-distance movements between grazing and water sites of livestock, particularly in times of drought.

Grazing cattle are not evenly distributed across the landscape, reflecting their foraging preferences. Several factors likely contribute to this patchy distribution. First, the availability of permanent water, settlement, and the quantity and quality of forage have been documented to influence movements by livestock. Second, impediments to movement also likely influence the range use of cattle. For example, various ethnic communities can only graze in areas where other "friendly" communities reside, while agricultural land use and disease vector infestations play a major role to preclude the use of forage resources in specific areas. Finally, accessibility has also been shown to influence the movements of cattle and overall patterns of range use.

A mathematical function was created to describe the grazing suitability for cattle on the landscape. Grazing suitability was determined from five principal components: (1) amount of standing crop available to livestock, (2) slopes at the site, (3) ethnic compatibility, (4) distance from permanent/seasonal water, and (5) time since previous occupation by the cattle herd. Each component was parameterized and a final product of suitability of a site for each of these components produced.

Herds. The herd object type was created to represent cattle in an 11 km by 11 km area containing several cohesive herds (approximately 30-50 head each), as they graze and move across the landscape. Because cattle often aggregate at or near settlements where there is permanent water, 186 of these sites were located as the initial locations for the cattle herds (this value keeps being adjusted as more data on water points get collected and collated).

We assumed that humans manage the grazing process using a "win-switch" foraging strategy. Research indicates that cattle may utilize spatial memory and employ a "win-switch" foraging strategy where cattle (via humans in this case) find a productive site (i.e., "win") but then routinely move (i.e., "switch") to another location rather than continuing to forage at the productive site until the expected net energy gain drops below that of other locations, as predicted by optimal foraging theory. This strategy may promote rapid regeneration of vegetation at the productive site. Cattle also utilize spatial memory to avoid recently grazed areas and have been shown to avoid locations with depleted food resources for up to eight days. Field studies also documented that when cattle switched foraging areas, they tended to move to adjacent sites rather than traveling to more distant areas.

Movement rules were programmed for cattle herds in the model to simulate a win-switch strategy with spatial memory. Although cattle herds occur on both sides of the international boundary between Kenya, Ethiopia, and Somalia, we prevented movement across this international boundary for the time being until the rate of cross–border transfer has been adequately parameterized. To determine grazing quality, the grazing suitability value was adjusted on a daily basis to reflect the decreased preference of cattle for recently visited sites, and their increased preference for adjacent sites. The decrease in grazing quality due to previous occupation by a cattle herd declined over time, and was eliminated when eight days had passed since the occupation. Once the grazing quality of each feeding area was updated, the movement rule for a cattle herd was simply to move to the feeding area with the greatest grazing quality.

The forage grazing quality variable *f(t)* for each feeding area was used to describe a site's relative attractiveness to a cattle herd and represented the dynamic attractiveness of a feeding area to a given cattle herd based on its unique history. The desire to move to a cell with higher forage value (forage at time *t*) is captured by this factor of forage quality and is calculated as follows:

$$f(t) = a_h f(q)$$

where

$$a_h f(q) = \mathrm{Min}[\sum_i f^i, 1]$$

where

a_h is a parameter estimate
$f(q)$ is the forage quality
f^i is the summation for the factor for accessible forage

The forage that is closest to the source contributes most to the function of forage quality $f(q)$. Other factors that influence the presence of forage include slope factors, ethnicity, and a memory factor accounting for the last time since visitation at a particular site. $f(q_j)$ was determined by:

$$f(q_j) = [(\alpha f_j - \beta S_i Cos(A_{ij} - a_j)]/\delta_{ij})(\Delta t^H)(\varepsilon_j)$$

where
$f(q_j)$ is the forage quality factor for cell $_j$
f_j is the standing forage crop at cell *j* in *tonnes/ha*
S_i is the slope percent at cell *i*
A_{ij} is the azimuth to cell *j*
a_j is the slope aspect at cell *i*
δ_{ij} is the distance between cells *i* and *j*
Δt^H is time since last grazing
ε_j is a factor for ethnic acceptance

Other factors such as conflict and disease will be incorporated in due time as reliable data becomes available.

Simulations. Each simulation of the livestock movement model produced two general types of output. Maps detailed the cumulative visits by cattle herds to feeding areas across the modeled landscape, and tables of information detailed the distances moved by cattle during a simulation, rates of consumption at the sites, resource pressure at the sites, etc. The resultant patterns produced by the model (maps) were examined as well as the underlying processes that generated these patterns (individual movements). The determination and tweaking of the appropriate values for some of the parameters for the model is an ongoing research problem with good progress.

The model requires another year to complete but the basic functionality and spatial representation of the dynamics has been attained, reflecting a first-order set of rules derived from the PARIMA-LEWS program and from LEWS field teams in the region. Of particular note is the improved data on livestock density compiled by the LEWS teams and the new updated trekking hours maps for livestock to go to primary, secondary, and terminal markets.

Activity Six: Pilot study on application of integrated communication and computing analysis for improving livestock market information infrastructure and situation analysis in East Africa.

Problem Statement. The primary concern of this activity was to determine if new short message services of cell phones linked to a receiver/message server that is integrated with a 2-way internet satellite system linked with a centralized analysis

system can be effectively configured in a manner that is valued by decision-makers at multiple levels concerning livestock marketing information.

Approach. Working with Ian Moore, head of information systems technology at ILRI-Nairobi, TAMU Telecom, TAMU Distance Ed Center, and Verdisys Corporation, we conducted an IT analysis for setting up a two-way Internet satellite system to link a distance education center at the ILRI Nairobi campus. In addition, we tested two software packages in use of the short message service (SMS) cell phone text messaging systems reporting sales information from the Nairobi, Garissa, and Isiolo livestock markets.

Progress. In collaboration with the TAMU Telecommunications Physical Plant and the TAMU Distance Ed Technology Development Center, we negotiated an agreement with Verdisys Corp (Houston, TX) for a VSAT 2-way Internet satellite hub that was located on the ILRI campus in Nairobi and recently installed. The system has email and internet browser capacity, two phone/fax lines that are direct into the TAMU telecom system, a SMS text and voice cell phone server, and a high speed broadband video conferencing capacity. LEWS provided the equipment and ILRI provided the server and conference rooms and has agreed along with the International Centre for Research on Agroforestry (ICRAF)-Nairobi to pay the monthly fee of over $1600/month indefinitely. TAMU Telecom is paying for the two phone lines indefinitely and maintaining all distance education equipment and personnel on the U.S. side. We were also able to negotiate video conferencing licenses with WAVE3 (http://www.wave3software.com/download_ center.html) that allow computer-to-computer meetings with digital cameras for low cost distance education concepts in the future of LINKS. The initial cost is $190 USD per unit and then $15 USD per year maintenance. The constraint of the system is that the computer needs to be a newer generation Pentium microprocessor.

We purchased cell phones and scratch cards and distributed those to a select group of collaborators at the four Nairobi terminal markets and the Garissa and Isiolo secondary livestock markets to test the concept of receiving and transmitting price/volume information by kind and class of animal. A first-order SMS text code system was devised for effective transmission. The cost per market day was $0.13 USD or $6.80/year for weekly markets. Currently, the test has involved reporting three times a week for the daily Nairobi markets. The Kenya Livestock Marketing Services Division (LMSD) in the Ministry of Livestock and Fisheries Development in Kenya provided monitors in each of the test market locations to help test the concepts of sampling herds, reporting body condition, and training needs of monitors. The results of this test formed the basis of the upcoming LINKS project which will be integrated into the LMSD strategic plan for a national livestock marketing information system.

First Order Reporting/Retrieving Protocol. The SMS system can be used to send reports from the field on market prices according to specific markets, animal kinds, breeds, and classes. If a monitor is registered in the system, they will need to know their monitor code to send a message from the field. This is usually designated by their initials, unless there are already conflicting initials in the system, at which time an alternate code would be assigned to them. The following tables represent typical codes to send messages that are currently being tested. It should be noted that only

the marketing code aspect of the system was tested as the other activity codes are to be an active part of the LINKS/GL-CRSP project.

Market codes.

Market Name	*Code*
Nairobi	NAI
Garissa	GAR
Isiolo	ISI

Monitor codes.

Monitor Name	*Code*
Kristen Zander (example only):	KCZ
Jerry Stuth (example only):	JWS

Message kind codes.

Message kind	*Code*
Conflict	C
Water	W
Disease	D
Market	MK*
*(only code currently being tested)	
Forage conditions	F
Personal message	PM

Message type codes.

Message type	*Code*
Send	S
Receive	R

Camel, goats, sheep, and horses would be coded the same way as the cattle classes below, using CA, G, S, and H as the middle indicator for animal kind.

Animal class codes.

Animal class	*Code*
Immature cattle female	ICF
Immature cattle male	ICM
Immature cattle castrate	ICC
Immature cattle all	ICA
Mature cattle female	MCF
Mature cattle male	MCM
Mature cattle castrate	MCC

Breed codes.

Breed name	*Code*
Boran	B
Zebu	Z
Mixed	M

A monitor in the field would dial the SMS cell phone, which is attached to an Active SMS process waiting for incoming calls. The process is launched when a call is received, and parses the information from the message and places it into a database. The codes above are used to lookup the appropriate natural language text, so that users can receive information from the system once it has been summarized. Below is an example of a monitor sending in information on the Nairobi market on October 31, 2003:

*MK S NAI JWS 10/31/03 ICF*B*5* 10000*57 MCF*Z*4*12370*432*

First, the monitor sends the appropriate code designating what kind of message is being sent. Here, it is a market message. Using the lookup table provided, they would know to begin the message as "MK". Next, they tell the system whether they are sending or requesting information, by designating "S." The market that they are sending is "NAI," or Nairobi, as parsed from the lookup table. "JWS" is the sender and is verified by the system as a valid user in the system. If someone attempts a send on the system that cannot be validated in the lookup table, the system will place the message in an unparsed table and send notification that there was an unauthorized attempt to use the system. The date that the market information was collected on is entered next.

Following this set of static information, the user can enter as many classes of animals as possible in one message, up to 156 characters, which is all that a single SMS message can accept. This part of the message is divided by

the asterisk character. The format of the entry is class code, breed code, body condition score, price, and volume. Multiple entries are separated by a space. The first entry above tells the SMS system that 57 head of immature female cattle, Boran breed, average body condition score of 5, were sold at the Nairobi market for an average price of 10,000 Kenya shillings. The user should assume that the price is in local currency. The second entry sends a message to the system that 432 head of mature female cattle, Zebu breed, average body condition of 4, were sold at the Nairobi market for an average of 12,370 Kenya shillings.

Each night the SMS system makes a call to the results table and summarizes the current day's information. The system assigns grades to sets of body condition score classes using the following breakdown:

Body Condition	Grade
< 3	Emaciated
3 - 4.9	Thin
5 - 7	Moderate
> 7	Fat

For example, there may be four entries for mature female cattle in the Nairobi market for the date October 31, 2003. If one entry was body condition 4, another 5, another 6, and another 7, the system would assign thin to the BCS 4 result, fat to the BCS 7 results and perform a weighted average calculation for volume and price on the two entries that fall into the moderate category. It will also assign a status of "no data" to those categories where data is not available, such as emaciated in the previous example. This process is creating a filled data set, which people can query for market conditions.

After the data set is filled each night, the data is ready to be retrieved by interested parties. These users will send a receive message to the system formatted like this:

MK R NAI B MCF

This text indicates that it is a market message kind, receive type, for the Nairobi market. The user is requesting information on the Boran breed, indicated by the "B" in the text, and would like the volume and prices for all grade of mature female cattle at this market. The system will return a message for the last date entered into the system by the market monitors to the caller's cell phone that will read like the following:

NAIROBI Mature cattle female Boran 10/31/2003 Moderate KES8450 Vol 526 Thin KES5200 Vol 46 Fat KES10100 Vol 23 Emaciated KES4000 Vol 19

The KES in the example above indicates the currency code for the country where the call is being placed. If there was no information in the database on emaciated cattle for the closest date to the time when the call was placed to the system, the emaciated volume and price would read KES0 Vol 0, to indicate that no emaciated cattle of this type were sold at the Nairobi market on the specified date.

Gender

Overall, the LEWS program has impacted the full spectrum of gender including an array of age groups. Because information flows to communities and not select individuals in families, the impact is less gender-specific in nature. However, how the information is used can impact decision-making at the household level as it relates to gender and age. Obviously, decisions to sell and move animals, particularly large animals, are a male-dominated decision in East Africa. However, much of the small stock decisions relative to sales are under the purview of wives of those male decision-makers. Elders in the form of village leaders have a large influence on the sense of urgency to react and how to react to

drought information. The reader is referred to the section on the perception survey to determine how LEWS was affecting the decision-making process and how gender was impacted.

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 two female graduate students and one female systems analyst working in the TAMU-LEWS project in the U.S. One recently completed her program and went to work for the University of Wyoming Extension Service. Currently, there are seven in-country women team scientists involved in the LEWS program. Two of the female scientists are the country coordinators for LEWS in Ethiopia and Tanzania. Three of the women are zone coordinators and the other two women are site managers. There are also site monitors who are women. The following are their specific responsibilities, by country.

United States. A female M.S. graduate student, Ms. Zola Gibson completed her M.S. program at TAMU, graduating in December 2003. She verified the prediction of PHYGROW in Laikipia district and surveyed pastoral communities on their perceptions of drought. She worked with the Mpala Research Centre (http://www.nasm.edu/ceps/mpala) in Central Kenya. Ms. Kristen Zander plays a key role in development of software for the LEWS project and is completing a M.S. program on factors affecting adoption of the nutritional management technology in the context of information technology.

Ethiopia. Dr. Zinash Sileshi, Animal Scientist, was the in-country coordinator for LEWS. She is also the director of the Livestock Research Program for the Ethiopian Agricultural Research Organization (EARO). Dr. Sileshi stepped down as the country coordinator recently due to other commitments and nominated Mr. Dereje Fekadu, at EARO Holetta to succeed her. The LEWS project contact within the Disaster Prevention and Preparedness Commission (DPPC) of Ethiopia is Ms. Belatu Tefera, team leader for the pastoral surveillance team. The DPPC is expected to be the home for the technology developed by LEWS, and the process of institutionalizing is currently underway.

Tanzania. Ms. Stella Bitende is the National Coordinator of LEWS in Tanzania. She was Assistant Director - Livestock Research, Ministry of Agriculture & Co-operatives, Division of Research & Development. Her position has provided a focal point for consultation on technical and operational details of the relevant commodity and research for the sub-program. In her capacity as a Lead Scientist, Ms. Bitende represents the sub-program on collaboration issues with external partners in research and development as the need arises. Ms. Bitende is now country coordinator for Heifer International at the close of the LEWS project. Ms. Margaret Kingamkono, of the Ministry of Agriculture in Arusha, is the LEWS Northern Tanzania coordinator, implementing many new innovations in the communication of LEWS information with pastoral communities.

Uganda. Ms. Grace Ebiyau 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 coordinates fecal sampling activities in southwest Uganda. She is the National Research Coordinator for veterinary medicine and animal health. 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.

DANIDA is funding a Ph.D. program at Makerere University for Mrs. Rose Omaria, who is a practicing veterinarian in Uganda. Mrs. Omaria was 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 make this a very important training event

Kenya. Mrs. Jane Sawe, a lecturer at the Department of Animal Science, Egerton University, has joined the LEWS zonal team in Northwestern Kenya. Ms. Elizabeth Muthiani has taken over coordination of the southern Zone of LEWS in Kenya. We were also able to negotiate a new MS student, Ms. Briget Ochieng of the Tegemeo Institute at the University of Nairobi to place her in a program to begin the process of investigating price efficiency between the Nairobi cattle markets and the two main markets in Garissa and Isiolo.

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 in the target. 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 inclusion into our monitoring route programs in all of the host countries. Three of the 15 households in southwestern 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 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 underway to reorganize the information flow from different Early Warnng System (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 (MoARD). The MoARD has submitted a Technical Cooperative Program (TCP) to FAO to help this process to go forward. LEWS representatives, including the PI of the project, have met with Mr. James Oduor, coordinator in MoARD to discuss how LEWS

could best be institutionalized in the reorganization process. The Arid Lands Resource Management project (ALRMP) is viewed by MoARD as a good working model through which LEWS technology could be integrated into the EW&FISU framework. Several meetings have taken place with Mr. Oduor and Mr. Maalim, National Coordinator of ALRMP in the Office of the President, to discuss the institutionalization of LEWS in Kenya. As of this writing, we have verbal commitment to identify key people in MoARD and ALRMP to liaison with LEWS teams and arrange training, set up networks, and establish computing capacity for the unit. The EW&FISU framework would ensure that all zones are covered by LEWS technology, considering that the mandate of ALRMP would be expanded to all pastoral regions of Kenya. Other collaborating organizations in the EW&FISU include the Kenya Meteorological Department, Department of Resource Survey and Remote Sensing, Central Bureau of Statistics, Ministry of Health, FEWS NET, FAO, and Arid Lands Resource Management Project.

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 supports the process of institutionalization in Uganda. An EWS unit is being established in NARO this year to remedy the high turnover in the Ministry of Agriculture. LEWS will be focusing training and infrastructure development in this unit.

Ethiopia. Continued dialogue with the national Early Warning Department of the Disaster Preparedness and Prevention Commission and Relief Agency has been maintained with the expectation that the technology and training will move forward once the systems function has been tuned to Ethiopia's extensive conditions, and the Ethiopian Agricultural Research Organization (EARO) has been set up with a functioning NIRS fecal profiling lab. The training workshop conducted on LEWS technology for the Early Warning Staff is an attempt to speed up the institutionalization process.

Tanzania. The Ministry of Agriculture has an established crop monitoring and livestock disease-monitoring program. The livestock component is linked with the Organization of African Unity-Interafrican Bureau for Animal Resources (OAU-IBAR). We are targeting the LEWS technology suite toward OAU-IBAR. The national coordinator of LEWS, Stella Bitende, is heading up the discussion with the Ministry of Agriculture and OAU-IBAR representatives. This discussion is in its infancy and we cannot provide any more insights on progress at this point in time.

ASARECA Crisis Mitigation Office. LEWS has invested in intensive training of an information officer and a biophysical modeling technical officer in the ASARECA Crisis Mitigation Office (CMO) located at ILRI-Nairobi (see capacity building section). The TAMU LEWS group has been working with the CMO to help integrate the LEWS concept into the ASARECA AARNET activities. Enhancing and upgrading the information capability of the office has involved collaboration with the International Livestock Research Institute's Information Dissemination Office. The goals of the Crisis Mitigation 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 FEWS-NET and major regional organizations. A partnership has formed between FEWS NET and LEWS, along with the Regional Center for Mapping Resource Development (RCMRD), Drought Monitoring Center (DMC), USGS FEWS NET, World Food Program, and Desert Locust Control Organizations to produce a monthly bulletin titled "Greater Horn of Africa (GHA) Food Security Bulletin." Nine bulletins have been produced as of this writing. We also have established a working relationship where the Disaster Prevention Management and Coordination Unit of the United Nations acquires our monthly reports to contribute to the Kenya Humanitarian Update.

Outreach

The primary mechanism for outreach has been the establishment of a mechanism to automate and distribute 10-d and monthly situation reports to government agencies and NGOs working with pastoral communities via the WorldSpace radio network. In Kenya, we have built the capacity for the Ministry of Agriculture and Rural Development to distribute our reports to district officers over most of Kenya's rangelands. Our zonal coordinators serve as an additional mechanism to distribute reports every ten days and monthly to their network of district officers and NGOs working with pastoral communities. We have established a mechanism for translation of our reports and dissemination of the reports into the district offices and NGOs in northern Tanzania. The LEWS Tanzania team established a booth at the National Farm Show in 2002 and was able to brief attendees on the LEWS program, including the Prime Minister and Minister of Agriculture. Each country has different dissemination mechanisms, with NARO playing a stronger role in Uganda. In Ethiopia, EARO was the lead organization but with the reorganization and decentralization of government function into the provinces, we have had to work with the pastoral development commissions in the Somali and Oromia regions to place key people into those regions.

Developmental Impact

Environmental Impact and Relevance. The central thrust of the LEWS program is to provide information on impending drought with sufficient lead-time to allow the government, NGOs, and pastoral communities to react to the conditions in a timely manner and prevent resource degradation. Improved decision-making leads to the maintenance of critical plant cover and recycling of carbon back into the soil, which maintains the hydrological integrity of the ecosystem and results in less soil loss and vegetation of a higher ecological state.

Agricultural Sustainability. Timely decision-making by livestock owners concerning the availability of forage supply, movement, and the 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 the 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 the 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, they have the opportunity to rotate (migrate) off the affected range before an irreversibly detrimental trend intensifies.

Contributions to U.S. Agriculture. Improved NIRS predictions of the diet quality of livestock will have a significant impact on the quality of predictions provided to ranchers throughout the U.S. via the national service lab at the Grazingland Animal Nutrition Lab, at Texas A&M University. Currently, this lab provides nutritional advisories to over 3,000 ranchers throughout the U.S. via the NIRS/NUTBAL nutritional management system. The technologies assembled and used in this project will be directly transferable to U.S. grazinglands. The new EQIP (Environmental Quality Improvement Program) has designated that the NIRS/NUTBAL nutritional monitoring program is eligible for incentive payments for over 35,000 livestock producers. The USDA Risk Management Agency adopted the concept of using biophysical models to generate forage loss assessment as a basis for the new national forage loss insurance program that will affect approximately 32% of livestock producers in the U.S. and over $695 million in forage assets. USDA RMA has accepted the feasibility study for this technology and has issued a task order for the insurance industry to implement the system over the next two years, with a first generation system tested in 2004, followed with full implementation in 2005.

The USDA Risk Management Agency recently approved funding as part of their partnership program to test the concept of blending ranch-specific weather data with the PHYGROW modeling system and livestock fecal profiling to provide a Forage Risk Assessment Management System (FRAMS) for the ranching industry. A pilot study has just been initiated for New Mexico, Texas, West Virginia, and Wyoming.

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 on initiating conditions (e.g., weather and remote sensing information) and a delayed post-effect (e.g., cattle weight and body condition loss) appraisal system. 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, losses

in forage supply, and decline in milk production. More timely destocking strategies will allow pastoralists to maintain their assets through crisis and assure greater ecosystem integrity, allowing the ecosystem to respond more rapidly after droughts run their cycle.

Also during this past 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 LEWS teams and relief monitoring agencies 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:

1. An 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.
2. Improved shared understanding and recognition of the importance of livestock in early warning systems. As is evident from the national agricultural early 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 to the LEWS project to remedy this situation.

The national outreach specialists of ministries and NGOs were provided training in the use of the various biophysical models and the spatial analysis tools employed by 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 scientists 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 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 between the various LEWS teams, Texas A&M, and national and international organizations involved in early warning.

In Ethiopia, we intensified our working relationships with DPPC, Oromia Pastoral Development Commission (OPDC), the Somali Pastoral Development Council, and Save the Children-UK.

The LEWS project also strengthened linkages with the FEWS regional representative in East Africa and EROS FEWS NET.

Collaboration with International Research Centers (IARCS) and Other CRSPs. The primary IARC collaborators are scientists located at the International Livestock Research Institute in 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,

integrated 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.

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 smallholder dairy technology in those regions.

This past year we have established a two-way Internet satellite connection between TAMU's Internet II node and the ILRI-Nairobi campus. ILRI agreed to provide the monthly fees in collaboration with ICRAF to ensure long-term sustainability of the system. We were able to locate the SMS cell phone text messaging system within their server room, maintained by ILRI system administrators. ILRI provided the distance education conferencing room to help us provide training for the LEWS and future LINKS project personnel.

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 aid in the level of preparedness and mitigation of the effects of drought. 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 the 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 livelihoods depend 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. Pastoralists' wealth is in their livestock, thus early warning information provided by LEWS could help ensure continued financial security for individuals and their families.

Support for Democracy. A livestock early warning system will improve the capacity of the people in East Africa to monitor and understand the dynamics of food security within their borders and throughout the region. Alerts from a livestock early warning system, with respect to droughts and other natural disasters, will reduce mass movements of people and livestock, which have traditionally been sources of conflict. 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.

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 for disaster preparedness. A proactive early warning system will help in making people in the region less vulnerable to disasters by alerting them of an impending crisis and provoking a humanitarian assistance response from local and international relief systems (e.g., governments, donors, and NGOs). The United States government, through USAID/OFDA, spends a lot of money on humanitarian crisis created by drought in East Africa. On October 29, 2002, the U.S. Embassy in Addis Ababa declared a disaster in response to the continuing drought situation in Ethiopia. To date in FY 2003, USAID/Office of Foreign Disaster Assistance (OFDA) has provided more than $30.8 million to support emergency water and sanitation, health and nutrition, and agricultural recovery activities in drought-affected areas nationwide in Ethiopia alone. This past year, all food emergency needs in the country have been met for the first time. This improved response could be partly attributed to timely early warnings, which are being issued by the DPPC, FEWS, LEWS, and other agencies working in the country.

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Leveraged Funds and Linked Projects

The LEWS project 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 $729,605 was leveraged this year alone within the group, not counting the normal cost share funds of Texas Agricultural Experiment Station salaries noted in the grant budget for 2001-02. Specific grants and funding levels are as follows:

DANIDA - $26,500 - Ph.D. training program for Ms. Rose Omaria. Ph.D. program is funded to develop pregnancy testing calibration equations for cattle and goats to meet both training and science objectives in the LEWS project. She is attending Makerere University and was given intensive short-term training at Texas A&M University GANLAB.

DANIDA - $25,070 - Ph.D. training program for Mr. Steven Byenkya. This is the final 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.

NUFFIC - $41,939 - Ph.D. Training in range management for Mr. Negusse Kidane from Eritrea. This program is focusing on development of NIRS fecal profiling systems for equines and enhancement of the NUTBAL goat performance prediction model. Mr. Kidane will also be setting up LEWS monitoring sites in Eritrea in May 2004.

SANREM CRSP - $80,000 - Global decision support system for assessing the impact of policy and technologies related to food security – Year 5. Personnel in TAMU-

FEWS are value-added funded via funds in SANREM CRSP, as many of the technology/ methodology enhancements help support efforts in LEWS as well as SANREM. Funded to Dr. Clark and Dr. Stuth.

USDA-NRCS - $66,000 - GSAT resource planning system development for assessing carrying capacity of rangeland systems. Technology developed in this program is used in the livestock movement and marketing technology being developed in LEWS/LINKS. Funded to Dr. Stuth.

USDA-NRCS - $180,000 - National animal nutrition and well-being program for the U.S. using the NIRS/NUTBAL PRO Nutritional Management System. This is the fourth and final year of funding. All technology generated in this program is deployed in LEWS. Funded to Dr. Stuth.

EU – ASARECA Crisis Mitigation Office - $150,000 - Funding of the personnel to support crisis mitigation information activities and collaborate with LEWS.

Noble Foundation - $35,000 - Development of early warning system technology for landowners. Funded to Dr. Stuth.

International Fertilizer Institute - $2,417 - GIS applications for LEWS. Funded to Dr. Stuth.

USDA-RMA - $95,000 - Development of integrated automation technology for spatial modeling of fire risk assessment on grazinglands. Funded to Dr. Stuth.

Kelleher Professorship - $27,679 - Enhancing decision-making of livestock producers. Provided to Dr. Stuth.

Training

In Progress

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

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

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

Negusse Kidane, Ph.D., Dec. 2004, Range Science, Texas A&M University.

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

Zola Gibson, M.S., Dec. 2003, Range Science, Texas A&M University.

Kosi Awuma, Ph.D., Dec. 2003, Range Science, Texas A&M University.

Kristen Zander, M.S., Dec. 2003, Ag. Development, Texas A&M University.

Laban Macopiyo, Ph.D., Dec. 2004, Range Science, Texas A&M University.

Completed

Amsalu Sisay, M.S., Dec. 1999, Range Science, Alemaya University.

Sarah Ossiya, Ph.D., August 1999, Range Science, Texas A&M University.

Mohammad Hamid, Ph.D., August 2002, Range Science, Texas A&M University.

Short term: Workshops, Short Courses

All LEWS coordinators attended the GL-CRSP Program Conference in Washington, D.C. in October 2002.

Capacity Building in Livestock Early Warning Tools, February 10 -20, 2003, Nazareth, Ethiopia.

Collaborating Personnel

United States of America

Jay Angerer, Assist. Research Scientist, Texas A&M University.

Jim Bucher, Systems Analyst, Texas A&M University.

Paul T. Dyke, Research Scientist, Texas A&M University.

Abdi A. Jama, Assist. Research Scientist, Texas A&M University.

Robert Kaitho, 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.

Ethiopia

Azage Tegegne, Animal Scientist, International Livestock Research Institute (ILRI).
Abule Ebro, Animal Scientist, Adami Tulu Agricultural Research Center.
Dawit Negessa, Lab Technician, ILRI.
Zinash Sileshi, Animal Prod. Researcher, Ethiopian Agricultural Research Organization.
Bayissa Hatew, Animal Scientist, Holetta, Ethiopian Agricultural Research Organization.
Dereje Fekadu, Animal Nutritionist, Holetta, Ethiopian Agricultural Research Organization.
Getachew Haile, Animal Production, Adami Tulu, Oromia Agricultural Research Organization.
Dubale Adamasu, Animal Production, FarmAfrica.
Suleiman Mohamed, Economist, Save the Children - UK.

Kenya

Henry Cheruiyot, Director Research Inst., Kenya Agricultural Research Institute.
Philip Leparteleg, Drought Preparedness Intervention and Recovery Program, Office of the President.
Mahboub Maalim, Arid Land Resource Management Project, Office of the President.
Nicholas Georgiadis, Director, Mpala Research Centre.
Robert Kaitho, SANREM/LEWS/KARI/ILRI, Liaison Research Scientist.
Roger Kamidi, Data Analyst, ILRI.
Raphael Marambii, Information Officer, ILRI.
Russell Kruska, GIS Researcher, ILRI.
Salim Shaabani, Aridland Resource Management Project, Office of the President.
William Mnene, Rangeland Management, National Range Research Center.
Jean Ndikumana, Network Coordinator, ILRI.
Jane Sawe, Animal Production Scientist, Egerton University.
John Kariuki, Animal Scientist, Naivasha National Animal Husbandry Research Centre.
Francis Mwangi, Lab Technician, Naivasha National Animal Husbandry Research Centre.

Tanzania

Suleiman Kaganda, Animal Scientist, Ukiriguru Agricultural Research Institute.
Rashid Kidunda, Range Ecologist, Sokoine University, Tanzania.
Angello Mwilawa, Range Scientist, Mpwapwa Agricultural Research Institute.
Stella Niyikiza Bitende, Forage Scientist, Selian Agricultural Research Institute.
Nicholaus Massawe, Animal Scientist, Selian Agricultural Research Institute.
Rashidi Kadunda, Range Ecologist, Sokoine University, Tanzania.

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
Rose Omaria, Vet Officer, National Agricultural Research Organization.
Emily Twinamasiko, Vet Medicine/Animal Health, National Agricultural Organization.

Collaborating Institutions

Ethiopia

Adami Tulu Agricultural Research Center
P.O. Box 35
Ziway, Oromia Region
Ethiopia

Department of Animal and Range Science
Mekelle University College
P.O. Box 231
Mekelle, Tigray, Ethiopia
Phone: 251-03-400-512
Fax: 251-03-400-983

Ethiopian Agricultural Research Organization
P.O. Box 2003
Addis Ababa, Ethiopia
Phone: 251-1-612633-41
Fax: 251-1-611222

Holetta Research Center, Ethiopia
P.O. Box 2003
Addis Ababa, Ethiopia
Phone: 251-1-512579
Fax: 251-1-611222

International Livestock Research Institute (ILRI)
Box 5689
Addis Ababa,Ethiopia
Phone: 251-1-338290
Fax: 251-1-338755

Oromia Regional Agricultural Office/
Southern Rangeland Development Unit
Yabello, Ethiopia
(location of S. Ethiopia LEWS office)

Kenya

Kenya Agricultural Research Institute (KARI)
P.O. Box 57811
Nairobi, Kenya
Phone: 254-2-583301-20
Fax: 254-2-583344

International Livestock Research Institute (ILRI)
P.O. Box 30709
Nairobi, Kenya
Phone: 254-2-630743
Fax: 254-2-631499

Arid Lands Resources Management Program (ALRMP)
Office of the President, Republic of Kenya
P.O. Box 53547
Nairobi, Kenya
Phone: 254-2-227496
Fax: 254-2-227982
E-mail: ALRMPHQ@africaonline.co.ke

Egerton University, Kenya
Department of Animal Science
P.O. Box 536
Njoro, Kenya

National Range Research Center (NRRC) Kiboko
P.O. Box 12
Makindu, Kenya
Phone: 254-0302-22456/22479
Fax: 254-0302-22459

National Dryland Farming Research Center – Katumani
P.O. Box 340
Machakos, Kenya
Phone: 254-0145/20206/7
Fax: 254-0145/20186

Mpala Research Centre
P.O. Box 555
Nanyuki, Kenya
Fax: 254-176-32208
Email: hammock@africaonline.co.ke

Tanzania

Livestock Production Research Institute (LPRI)
P.O. Box 202
Mpwapwa, Tanzania
Phone: 255-61-24526
Fax: 255-61-320063

Selian Agricultural Research Institute
P.O. Box 6024
Arusha, Tanzania
Phone: 255-57-3883/2868
Fax: 255-57-8557

Sokoine University
Dept. of Animal Science and Production
P.O. Box 3004
Morogoro, Tanzania
Phone: 255-56-4617
Fax: 255-56-4562

Uganda

Makerere University
Department of Animal Science
Box 7062
Kampala, Uganda
Phone: 256-41-532269
Fax: 256-41-531641

Namulonge Agricultural and Animal Research Institute
P.O. Box 7084
Kampala, Uganda
Phone: 256-41-341554
Fax: 256-41-341554

Serere Agricultural and Animal Production Institute
Soroti, Uganda

Publications

Issued 12 Greater Horn of Africa Early Warning Bulletins, jointly produced with FEWS NET, USGS, DMC, UNEP, and KMO (http://cnrit.tamu.edu/aflews/bulletins.cgi?type=GHA).

Issued 12 monthly Situation Reports each for Kenya, Uganda, Ethiopia, and Tanzania via RANET, ALIN, and LEWS coordinators that reach worldspace satellite radios across the zone (http://cnrit.tamu.edu/aflews/bulletins.cgi?type=SR).

Issued 36 dekadal maps and situational reports over the web (http://cnrit.tamu.edu/aflews).

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Principal Investigator

Lead Principal Investigator. Dr. Jerry Stuth, Department of Rangeland Ecology and Management, Texas A&M University, College Station, TX 77843-2126. Phone: 979-845-5548; Fax: 979-845-6430; Email: jwstuth@cnrit.tamu.edu.

Improving Pastoral Risk Management on East African Rangelands

Narrative Summary

This was the sixth 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 enhancing livelihoods—for pastoral and agro-pastoral people in northern Kenya and southern Ethiopia. Foundation concepts include the exploration of opportunities to better diversify incomes and assets, and how to improve the use and delivery of information and various public services. The year is best characterized by the following achievements: (1) Twenty-four publications were produced, including peer-reviewed papers, conference proceedings, abstracts, theses, popular articles, and reports; (2) twenty-eight professional presentations were given at venues in East Africa, the U.S., and Europe; (3) five African students affiliated with PARIMA received master's degrees at Egerton University, with another seven students in the pipeline at universities in the U.S. and Kenya; (4) we held six formal meetings pertaining to research planning and policy issues, with 116 participants in total. Nine other events, largely sponsored on behalf of PARIMA Outreach by the USAID Mission to Ethiopia, attracted over 1,800 participants—largely pastoralists, development agents, and government officials; (5) an annual survey of 330 pastoral households has been successfully implemented in southern Ethiopia and northern Kenya, a continuation of work started in 2000 that will provide an unparalleled time series concerning pastoral risk management; (6) interactive visits were successfully undertaken with our six pastoral communities in northern Kenya whereby research results were presented and comments received from residents. This highly unusual activity helps complete a loop between research and the ultimate beneficiaries of the project; (7) over 40 policymakers from various strata in Ethiopia and Kenya were successfully engaged by PARIMA in two meetings to forge linkages between research and decision-making. Two provisional policy working groups were formed to provide conduits for future engagement; (8) strengthening the role of African leadership in PARIMA has begun. Three planning meetings were held to draft work plans involving KARI, OARI, and Egerton University in various aspects of cross-border collaboration between Ethiopia and Kenya; and (9) the World Bank has recently initiated a large-scale, multi-million dollar project in Ethiopia called "the Pastoral Community Development Project (PCDP)," with an implementation timeline of 15 years. The PCDP is founded on participatory approaches pioneered by PARIMA in southern Ethiopia. We have remained true to our original problem model. Work plans and outputs in Year 6 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 by the GL-CRSP.

Research

Activity One: Research on Risk at the Individual, Household, and Community Level

Problem Statement and Approach. One of the core issues investigated by the PARIMA project is the extent to which pastoralists share a common perception and experience of risk. The common assumption is that most risk experiences are common to most pastoralists. This assumption has important implications for the way that 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, local systems have greater capacity to manage risk internally so long as a basic physical and institutional infrastructure is in place. So one of the first research activities of PARIMA 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 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 of these communities are Boran, with one each from the Rendille, Ariaal, Il Chamus, Gabra, Samburu, and Guji. The survey was launched during March 2000 and was successfully repeated on a quarterly basis over the next two years, ending in June 2002. Survey work has been 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 purposely chosen so as to capture important differences in agro-ecology, access to towns and infrastructure, and ethnicity. Individual-level surveys have not only been fielded to household heads, but also to randomly selected junior male and female adults from each household in order to illuminate gender and generation 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 has been made to capture actual behaviors as well as risk perceptions. Updated descriptions of survey findings have been documented in GL-CRSP Annual Reports for 2001 and 2002. For 2003 we planned to embark on an annual survey (reduced frequency) of the same 330 households with an additional goal of capturing dynamics related to the drought recovery cycle. The last drought occurred in the late 1990s while the next regional livestock crash is anticipated to occur around 2005. The intervening years can be referred to as a drought recovery phase.

Progress. Work on this activity has been dominated by data processing and writing in 2002-03. In addition, we successfully conducted the annual repeat survey during August and September of 2003. In this report we add some detail and new insights pertaining to this activity.

Pastoral Sedentarization. Pastoral sedentarization is a major trend in East Africa, and there is debate about its social and ecological costs. We are interested in relationships between sedentarization and well-being for pastoral households in northern Kenya. We used survey data collected from six sites from March 2000 to October 2001 in addition to other information. We found varied degrees of sedentarization and complex relationships among vulnerability, sedentarization, mobility, and household income diversification. First, we have found that sedentarization does not necessarily reflect a complete departure from pastoralism, nor does it always jeopardize pastoral production. Second, sedentarization does not always imply a loss of access to livestock, or a lack of mobility for livestock owned by settled households if satellite camps are maintained. Third, there is a great deal of diversification into non-pastoral activities by members of households while other members can remain engaged in mobile pastoralism. Lastly, there is a need to distinguish between increased vulnerability to livestock loss and increased vulnerability to food insecurity when households become sedentary. Overall, we find that what is often labeled sedentarization need not be antithetical with pastoral production. Households show great adaptability and innovation in adopting non-pastoral activities without fully abandoning mobile pastoralism.

Table 1 presents a summary of general features for the Kenyan sites where our data were gathered. Table 2 presents averages for a variety of measures by site that relate to the general themes of sedentarization and pastoral welfare. We discuss these findings by discussing each site in turn. Please refer to Tables 1 and 2 throughout.

In spite of losing over 80% of their livestock, the average household in Ngambo fared relatively well during the recent drought (1999-2000) in terms of food security and income. This is shown by their relatively high mean value for milk plus household expenditure. Households in Ngambo have access to work opportunities in the nearby town of Marigat, which has a lively market center and is connected by an all-weather road to the major city of Nakuru. People in Ngambo can also find work in a local irrigation scheme. Salary, wage labor, and trading account for over 60% of household income in Ngambo. Levels of formal education and current rates of school enrollment are the highest of any site in our study region.

In contrast to Ngambo, the average household at Dirib Gumbo lost over 80% of their livestock during the 1999-2000 drought. Their well-being does appear to have been negatively affected by that drought. Although

Table 1 - General features of sites studied by the PARIMA project in northern Kenya.

Site	District	Predominant Ethnic Group	Average Annual Rainfall (in mm)	Market Access
Dirib Gumbo	Marsabit	Boran	650	Medium
Ngambo	Baringo	Il Chamus	650	High
Sugata Marmar	Samburu	Samburu	500	High
Logologo	Marsabit	Ariaal	250	Medium
Kargi	Marsabit	Rendille	200	Low
North Horr	Marsabit	Gabra	150	Low

Table 2 - Ranked order of Kenya study sites with respect to different measures for human welfare and involvement in pastoral production. From top to bottom, sites are ranked from highest to lowest for each respective measure (with the exception of the herd loss column).

Higher mean milk value + expenditure[1]	More stable milk value + expenditure[2]	Higher mean income[3]	Higher non-pastoral income %[4]	Higher average herd size[5]	Lower maximum herd loss[6]	Higher water points used[7]	Higher enrollment in 2000 [8]
Ngambo	Ngambo	Logologo	Ngambo	Kargi	Kargi	Kargi	Ngambo
Sugata M.	Logologo	Sugata M.	Logologo	North Horr	Sugata M.	Logologo	Sugata M.
Logologo	Kargi	Ngambo	Sugata M.	Logologo	North Horr	North Horr	Dirib G.
Kargi	Sugata M.	Kargi	Dirib G.	Dirib G.	Logologo	Ngambo	Logologo
Dirib G.	Dirib G.	North Horr	North Horr	Sugata M.	Ngambo	Sugata M.	Kargi
North Horr	North Horr	Dirib G.	Kargi	Ngambo	Dirib G.	Dirib G.	North Horr

Notes:
[1] Defined using household level, two-week expenditure data and adding in the value of two weeks worth of home-consumed milk, defined using the local market value of milk. The maximum is $31, the minimum $10.
[2] Defined as the household-level coefficient of variation over time-periods for the measure described in (1). The maximum is 78%, the minimum 50%.
[3] Defined as total household cash income for a three-month period. The maximum is $125, the minimum $32.
[4] Defined as the share of the measure described in (3) that is not accounted for by livestock or livestock product sales. The maximum is 82%, the minimum 40%.
[5] Defined in terms of Total Livestock Units. The maximum is 20, the minimum 2.
[6] Defined as the maximum decline in the average of the household observations for (minimum herd size/maximum herd size)-1 during the period March 2000 to September 2001 of the measure used in (5). The maximum is -85%, the minimum -5%.
[7] Defined as the average number of water points visited by a household herd over a three-month period. The maximum is 3.3, the minimum 1.1.
[8] Defined as the percent of school age children who were enrolled in formal schooling in 2000. The maximum is 91%, the minimum 16%.

Dirib Gumbo is not distant from the major market town of Marsabit—and people at Dirib Gumbo have relatively high levels of education—they also have a relatively low share of their income from non-pastoral sources. Salary, wage labor, and trading account for only 30% of household income at Dirib Gumbo. This is probably because most of these households rely on rain-fed agriculture in "normal" years and seem to have relatively poor access to some types of wage employment. When the rains failed during the 1999-2000 drought, many of the households sold livestock to meet consumption needs, which may explain why the share of income from livestock and livestock products is relatively high.

The average household in Sugata Marmar was not severely impacted by the drought in terms of livestock loss, food insecurity, or income. Partially, this may reflect the fact that rainfall data from the area suggest drought was less severe in Sugata Marmar than in other areas of northern Kenya. It may also reflect the fact that households in Sugata Marmar have access to income-generating opportunities arising from a large weekly market. They also live close to markets where food can be purchased. Households in Sugata Marmar earn a relatively higher share of their income from trading (25%) compared to that from any other site. Combined with income earned from selling their own livestock and livestock products (45% of income), residents of Suguta Marmar earn considerable revenue from trade. The mobility of livestock in this area differs from that in others—perhaps

because there are more water points available in the Samburu grazing lands. By relying on satellite camps and multiple established households (i.e., a family head with multiple spouses maintains at least one domestic dwelling near an education facility), families at Suguta Marmar appear to have found a compromise between mobility and education, as is seen by the relatively high rates of school enrollment.

The average household in Logologo lost roughly half their livestock in the 1999-2000 drought, but this does not appear to have severely impacted welfare as measured by mean income, mean expenditure, or variability in expenditures. Logologo is the only site where the income share from salary (42%) outweighs the income share from livestock and livestock products (35%). Just over half the salary earners in our sample worked outside the area and were employed by NGOs, the Kenya Police, the Kenyan Armed Forces, the Kenya Wildlife Service, or as night watchmen in urban areas. Schools, government departments, and the police employ local salary earners. Households in Logologo have established links to the larger national economy that allowed their welfare levels to be relatively unaffected during the recent drought.

The results from Kargi provide an interesting nuance to our understanding of the process of sedentarization. Although Kargi households have settled, their animals remain highly mobile through an effective system of herding camps. The Kargi results show that pastoral production remains a viable strategy in some areas. Kargi herders are relatively well-off in terms of the mean and variance of the expenditure plus milk value measure, and they lost a relatively small percentage of their livestock to drought. Their isolation from market forces actually seems to have allowed them to pursue a form of mobile pastoralism that is well-suited to their environment.

Contrasting the North Horr results with those from Kargi provides a fuller understanding of these points. Households in North Horr appeared more mobile than households in Kargi. Many households in North Horr still shift their entire household to a new area in search of forage, while in Kargi only the animals were dispersed. However, results show that Kargi livestock were more mobile than livestock in North Horr. This means that grazing resources may be more evenly utilized by the inhabitants of Kargi. With regard to the viability of pastoral production, it should be noted that the main difference in the welfare measures between North Horr and Kargi is the larger—yet less variable—milk production in the latter site. Although it is not well reflected in the rainfall data for 1999 to 2001, the spatial distribution of rainfall observed in this area during the study period appeared to create more abundant forage in key areas used by herds from Kargi compared to those used by herds from North Horr.

There are several sets of practical implications pertaining to this work. First, income diversification is frequently discussed as an alternative to pastoralism. Our findings suggest it may be more useful to think of how income diversification can be used as a supplement to pastoralism rather than a replacement. Thus, the key is to provide sedentary-type services (for example, education and veterinary services) that benefit pastoral populations without jeopardizing mobile pastoralism and creating unwanted concentrations of people and animals around fragile settlement environments.

The second set of implications applies to education. In northern Kenya, education up to secondary school increases one's chances

of obtaining employment in the formal sector. Our data suggest this is particularly true in higher rainfall sites (Ngambo and Suguta Marmar) where sedentary forms of pastoralism have evolved and access to town-based education facilities is generally good. In other, more mobile and drier sites like North Horr and Kargi, such opportunities have not evolved as rapidly due to less complementarity between mobile forms of pastoralism and town-based facilities for formal education. In these areas effort should be made to move education facilities nearer to key grazing and watering points and/or adjust school calendars to account for seasonal movements of animals and people. Herders should not have to make a choice between the pursuit of pastoralism and sending children to school. Finally, for reasons bearing further investigation, educational investments in the sedentary community of Dirib Gumbo do not appear to have had a large payoff in terms of employment.

The third set of implications relates to veterinary services. The advent of para-vet ("barefoot") animal health services in northern Kenya is a welcome addition to pastoral systems and should be increasingly supported (para-vets are local people trained in basic aspects of animal health diagnosis and treatment and serve their communities). Often, pastoral animals are untreated—or treated by untrained herders—because distances to town-based veterinary services are often prohibitive. If an important goal for rangeland management is to keep animals widely distributed and feeding on the best forage rather than concentrated around settlements, then mobile para-vet services are critical to achieving this. Efforts should be made to increase the training support to para-vets and change government policies to recognize para-vets as legal service providers. This would allow para-vets to better access medicines and vaccines than is currently the case.

The fourth set of implications relates to land tenure and planning. Increased sedentarization can aggravate land conflicts in the vicinity of settlements. This often pits local groups against new immigrants and herders against farmers. Agricultural encroachment onto rangelands has been associated with certain patterns of sedentarization and can instigate conflicts related to land use and tenure, often to the disadvantage of local herders. Policies should be developed that recognize the rights of herder groups to customary water points and grazing areas and delimit the extent to which sedentary farming can expand into rangelands.

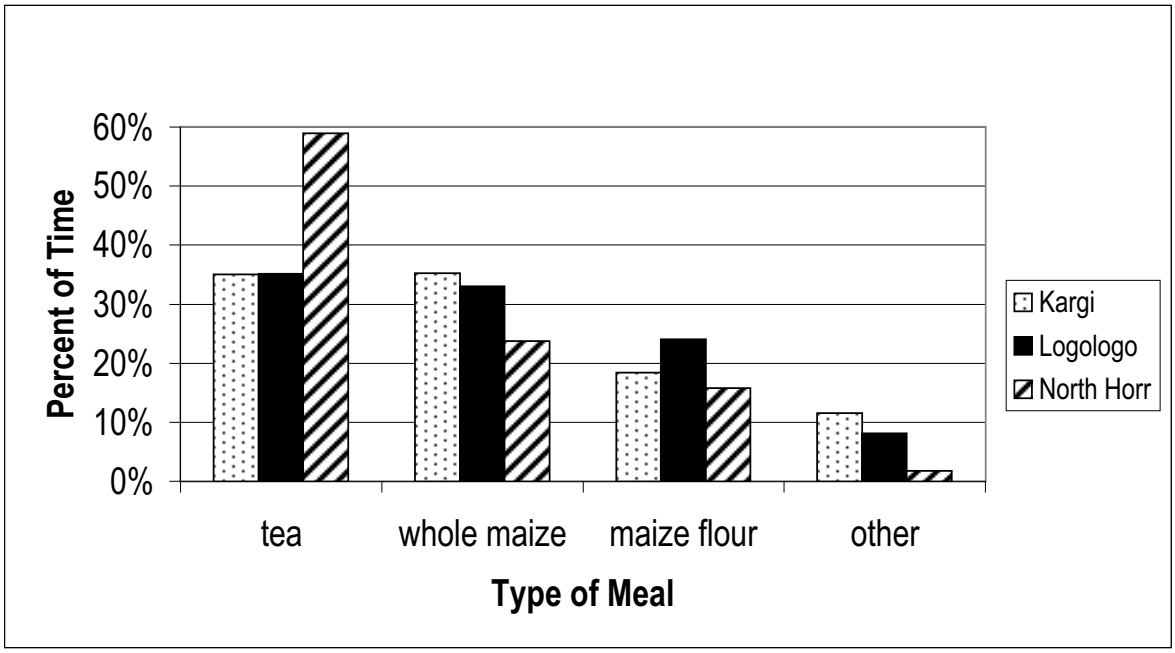
Use of Fuelwood—Implications for Local Environments. As pastoral populations settle, there is concern about the environmental impacts of sedentarization. In particular, fuelwood gathering can place intense pressure on local woody vegetation. Here we report preliminary findings from surveys of 87 pastoral households from three communities in northern Kenya conducted during 2000. The objective was to characterize harvest and use of fuelwood resources. Households used approximately 19 kg of wood daily (largely *Acacia* spp.). Most wood was used to cook maize. Comparison with findings from an earlier study suggests household daily fuelwood use is increasing in this area. Human dietary shifts associated with increased market involvement and increased provision of food aid —namely moving from milk-dominated to maize-dominated diets— is hypothesized to explain this increase. Experiments were conducted in 2002 to assess amounts of wood needed to cook whole-grain maize versus maize flour, as food aid is distributed as whole-grain maize. Results indicated that twice as much wood was needed to cook whole-grain

maize, suggesting that milling food aid prior to distribution could reduce demand for fuel, lower women's labor, and mitigate pressure on woody species. Findings suggest alternatives such as distribution of milled food aid and other efforts will be needed to reduce demand for fuelwood.

Some preliminary findings follow: (1) Of 238 fuelwood gathering trips recorded, only one was undertaken by a male. Fuelwood gathering is thus an activity of female adults and children; (2) fuelwood gathering took place about once every three days on average. The average trip took three hours; (3) people carried wood back home themselves 98% of the time. Camels and donkeys were used for the scant remainder. Wood gathering was dominated by use of machetes (60% of trips), breaking wood by hand (37%), or using an axe (3%). About 1.6 woody species and 48 pieces of wood were gathered per trip; (4) *Acacia* species (primarily *A reficiens, A. seyal, A. tortilis,* and *A. mellifera*) accounted for 57% of wood gathered. The next most common genera was *Suaeda* (*S. monoica* gathered exclusively around North Horr), accounting for 11% of all wood gathered. A variety of other species made up the remainder; (5) the average daily fuelwood inventory per household was 19 pieces weighing a total of 12 kg. The average weight per piece was almost 1 kg; (6) for 16% of 608 daily household observations, households borrowed fuelwood from other households, while a similar number gave fuelwood away. For 10% of observations households had purchased fuelwood, while for 4% of observations households sold fuelwood. For 1% of observations charcoal or other fuel was used for cooking; (7) the average household used a total of 19 pieces of wood per day for cooking. Time spent cooking was largely devoted to cooking tea and maize (Figure 1). In terms of amounts of fuelwood used, the largest use was for cooking whole maize (Figure 2). The cooking experiment indicated that cooking whole-grain maize required roughly twice (1.97) the amount of fuelwood that was required to cook an equivalent amount of ground maize.

This work has several practical implications. Results are preliminary and will be refined as the analysis proceeds. However, it appears that sedentarization has a two-fold impact on fuelwood resources. First, pressure is localized on woody resources around towns and settlements. Recall that the average wood gathering trip lasted three hours, and on the return leg the average load carried on a woman's back was in the 40 to 50 kg range. Neither vehicles nor animals played a significant role in fuelwood transport. There is little reason to believe the distance of the collection point from town has changed much from the estimate of 2.5 km forwarded by previous investigators in the early 1980s. Second, there appears to be a subtler impact brought about by a dietary change from a milk-based to a grain-based diet. The grain-based diet increases fuelwood requirements of households. These two factors lead to three main practical implications. First, we determined that a diet based on whole-grain maize required more fuelwood than one based on ground maize. Recognizing that food aid in this area is distributed as whole grain maize allows us to estimate that a switch in food aid composition from whole-grain to ground maize could reduce fuelwood requirements up to 4% per year and reduce the amount of time women spend gathering fuelwood up to 6%. These figures are estimated by utilizing information in the repeated surveys that record total annual food aid packages received by households and calculating the reduction in wood requirements and use if whole-grain

Figure 1 - Percent of time used for daily household cooking in three northern Kenyan towns during July and August, 2000. Items cooked included tea, maize (whole grain), maize meal, and all others combined.

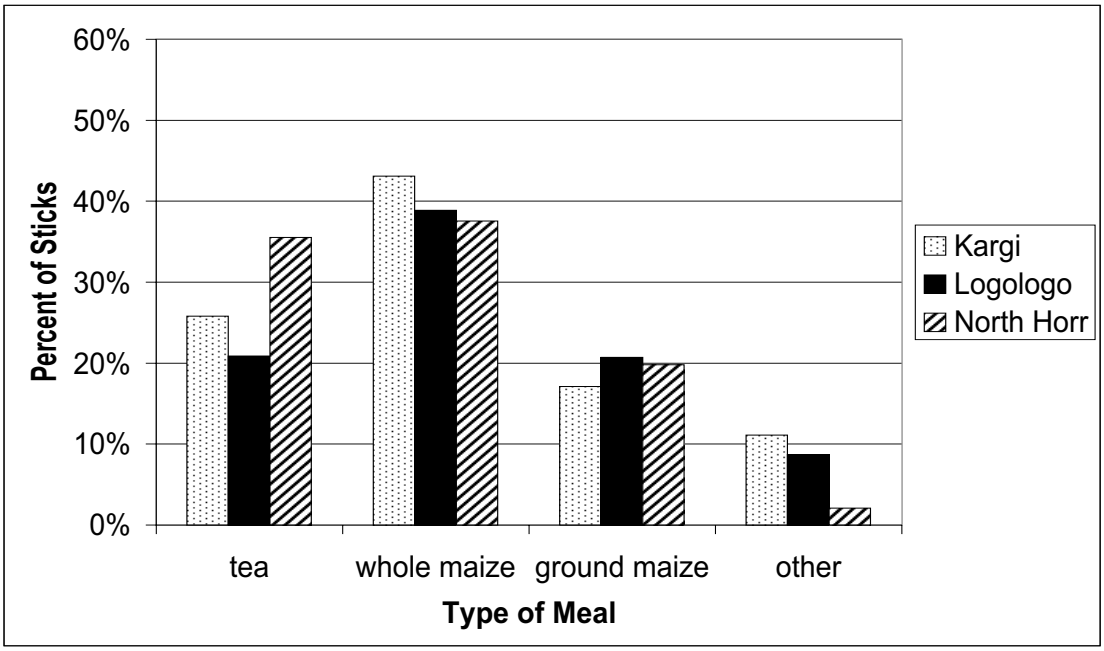


maize had been instead distributed as ground maize. This suggests that food aid distribution in the form of maize flour could reduce both women's labor and mitigate the rate of depletion for woody resources.

Second, more attention should be given to linkages among increased market involvement, dietary change, and higher fuelwood use among settled pastoralists. As pastoralists become increasingly involved in selling livestock and livestock products to purchase grain, pressure on local woody resources can increase. This would occur even in the absence of any increase in human population for a given area, and would be exacerbated where human population growth occurs. While there are some methodological differences in approaches taken, our estimate of household fuelwood use of 19 kg per day is over six times higher than that of previous investigators in the early 1980s who found a consumption rate of two to four kg per day. This suggests that household fuelwood use in northern Kenya has dramatically increased over a 17-year period. We are currently comparing our data with other findings to better understand what may have led to such a rapid increase in fuelwood use by households. Third, there is reason to question the sustainability of current use patterns. As suggested by KARI research, there is evidence that woody resources near pastoral settlements are decreasing due to overuse. Research into efforts to better manage fuelwood is critical, from the demand perspective (improved cooking and food preparation techniques) and the supply perspective (protection of existing woody resources, planting of new woody resources).

Welfare Dynamics, Poverty Traps, and Safety Nets in Northern Kenya. We use the quarterly repeated household head survey data to explore questions regarding the welfare

Figure 2 - Pieces of fuelwood used for daily household cooking in three northern Kenyan towns during July and August, 2000. Items cooked included tea, maize (whole grain), maize meal, and all others combined.

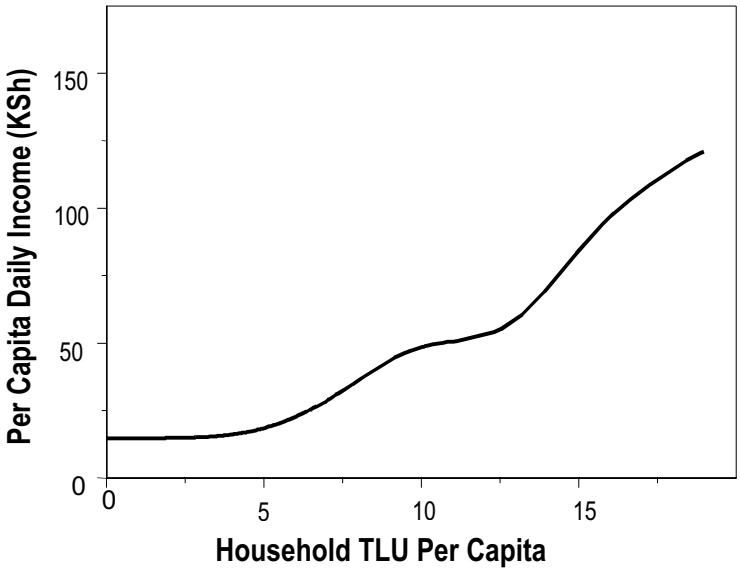


dynamics of pastoralist households and their response to highly volatile incomes and asset stocks. We find that poverty is deep and widespread in many of our communities. In Dirib Gumbo, a Boran community on the shoulders of Marsabit Mountain, every survey household fell below the Kenyan rural income poverty line of KSh 1239/person/month in each period of 2000-01. In Ngambo, 86% fell below the poverty line throughout 2000-01. Only 9% were able to climb out of poverty between March 2000 and December 2001, as recovery from the 2000 drought progressed. The poverty of these pastoralists appears extraordinarily persistent by international standards.

Two other striking patterns emerge from preliminary analysis of these data. First, income increases with herd size at an accelerating rate over most of the household wealth distribution, as shown in Figure 3. This suggests the existence of poverty traps wherein households with larger herds enjoy higher rates of return per head of livestock than do households with smaller herds, due to differences in ability to pay for veterinary care, supplemental feed, etc., and, perhaps especially, ability to migrate over longer distances in response to spatiotemporal variation in forage and water availability.

The second striking pattern concerns pastoralists' income risk and consumption smoothing behaviors. Economic theory posits that households faced with risky income will smooth their consumption, saving in good years and eating up their savings or borrowing in lean years so as to stabilize consumption over time. The literature on coping strategies, however, suggests that reduced consumption is among households' first response to severe shocks, typically preceding asset liquidation, contrary to the prediction of economic models of consumption smoothing. The PARIMA household survey data suggest that

Figure 3 - Household daily per capita income as a function of herd size per capital for selected sites in northern Kenya.



consumption smoothing indeed increases with household wealth, as proxied by herd size per capita in Figure 4. Wealthier households take on greater income risk, reflecting the greater risk aversion of poorer households, which induces them to choose less risky, lower return activities and asset portfolios relative to wealthier neighbors. The dashed line in Figure 4—which should be read against the right vertical axis—depicts the density of the per capita herd size distribution among these households—decidedly shifted towards the poor end of the spectrum. As can be seen, the modal household has less than one total livestock unit (TLU) per capita and has no statistically significant consumption smoothing. Their income stream actually appears slightly more stable than their expenditures. Only as one moves out well beyond the median of the wealth distribution does consumption smoothing become significant. This implies that under current circumstances, households have relatively little capacity to manage income shocks themselves without sacrificing current consumption. Given the meager consumption levels of these pastoralist households, this may imply considerable nutritional and health risk in the face of adverse income shocks.

Individual vs. Collective Rationality in Pastoral Production. In this study, based in large measure on household survey results from northern Kenya, we conducted a conceptual analysis as to whether livestock accumulation at the household level in pastoral systems is rational or not. We considered both the household and community levels in this analysis. It appears rational to accumulate livestock at the household level. First, income is directly related to herd size – as herds increase, household income increases. Second, wealth held in the form of livestock offers a higher rate of return over time than does wealth held in formal savings even if periodic herd losses are included are included in the calculations. In addition, accumulation at the household level is preferred to restocking through deploying formal savings in local livestock markets, as evidence suggests female animals are infrequently available in markets in the study area and herders indicate these animals are of questionable quality when they are available. Finally, herd size post crisis is an increasing function of herd size pre crisis, suggesting herd accumulation serves a self-insurance function.

With regard to collective irrationality, we find that there is limited evidence of negative externalities imposed by other herders on the

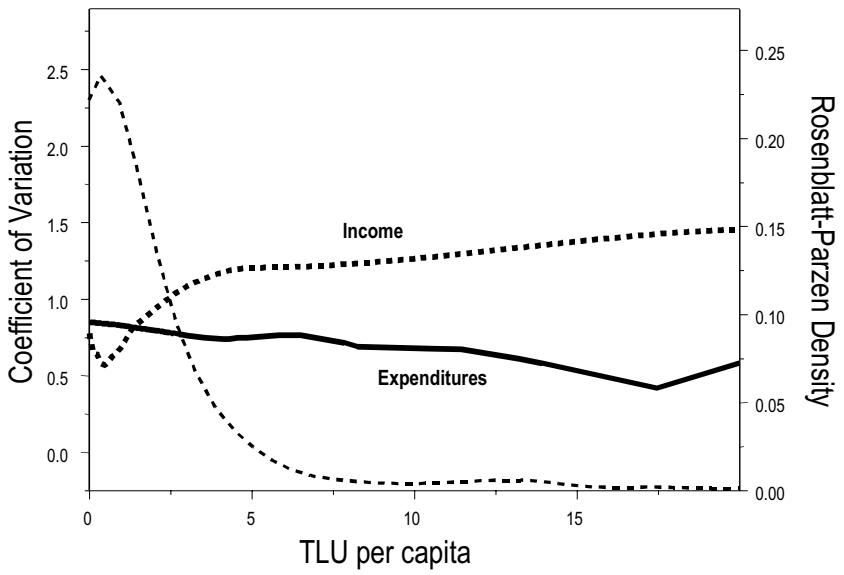
individual household. Aggregate herd size has not exceeded ecological carrying capacity in any year for which records exist. Rangeland degradation is occurring, but it is restricted to areas around towns. Degradation results from a sub-optimal distribution of animals, not larger than optimal herd size. Regression analysis finds that household level herd growth and milk production are not significantly influenced by the size of other households' herds. Analysis of subjective rankings of pasture availability finds there is some evidence of a localized negative labor externality brought about by other herders' stocking decisions.

The finding that herd accumulation appears to be economically rational at the household level and not detrimental at the collective level provides some measure of optimism for future pastoral development efforts. Many pastoral development efforts have been based on the premise that herd accumulation is collectively irrational and defined as an objective reduction in stocking pressure. The results of this study suggest that this record of failure may be partially explained by the fact that the conceptual underpinnings of development efforts in pastoral areas have been flawed.

Herd accumulation results from the economic logic of pastoral production in a risky environment. Whether herd accumulation also results from cultural values and tenure arrangements is somewhat irrelevant in this case. Herd accumulation at the household level does not appear to impose externalities on other households through rangeland degradation that cannot be addressed through policies influencing the spatial distribution of animals. In addition, efforts to reform cultural values or tenure arrangements in the hope of eliminating the "boom and bust" cycle and thus improving pastoral welfare run the risk of severely reducing household welfare without achieving this goal as the underlying cause of this cycle is misdiagnosed. As suggested by this and previous studies, the factors that lead to sudden herd loss may be unrelated to stocking pressure.

Development efforts that attempt to eliminate the bust phase by discouraging livestock accumulation or actively imposing herd limits should first establish that aggregate herd size influences household level losses in crisis periods. If bust phases are related to herd size externalities, limiting herd accumulation makes sense. If not, such policies reduce household welfare of an already largely poor population without

Figure 4 - Household consumption smoothing and income risk as a function of herd size per capita for selected sites in northern Kenya.



providing any compensating benefit. A similar argument holds for policies that assume production from the aggregate herd can be increased by decreasing aggregate herd size. It is conceptually possible, but the evidence in this study indicates that empirical support should be provided before policies are based on this assumption.

To the extent that collective externalities exist, this study finds they result from sub-optimal distribution of animals and may be compensated for by increased labor effort. The findings of this study suggest a way forward in pastoral development is to strengthen existing pastoral production systems. In the short to medium term, herd accumulation in such environments should be facilitated, not hindered. Efforts that support mobility should be designed to reduce externalities resulting from sub-optimal spatial distribution of accumulated animals. In a related study, the author notes that improved security in remote grazing areas and modifying the system of food aid distribution can improve the spatial distribution of animals.

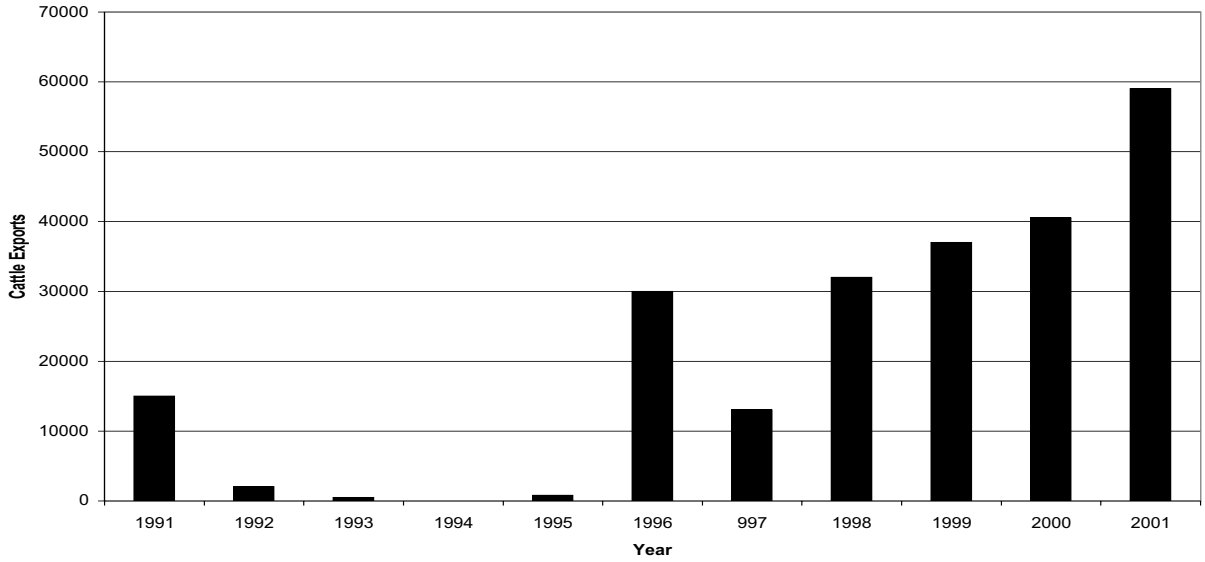
It is hoped that the findings of this study will challenge other researchers to identify empirically in what domains, and under what conditions, stocking externalities exist. Such research is critical. We caution policy makers that the findings of this study may not be applicable to other pastoral areas. We realize that it is as dangerous to base policy in pastoral areas on the assumption that externalities do not exist as it is to base them on the assumption that they do exist. However, we hope that these findings encourage researchers and policy makers to consider the irrationality of herd accumulation and the existence of negative externalities in pastoral production as hypotheses to be tested, rather than certainties on which policy can be based. The empirical foundation that such research will provide to pastoral development programs will help ensure that the record of failure characterizing past efforts need not characterize the future.

Activity Two: Thematic Investigations Dealing with Livestock Marketing, Rural Finance, and Natural Resource Management

Problem Statement and Approach. The broad objective of this activity has been to investigate how support systems such as livestock marketing, rural finance, natural resource tenure, indigenous social networks, and provision of climate forecast information affect pastoral risk management in our study region. Work has mostly been undertaken by African and American graduate students who have matriculated at U.S. universities. Livestock marketing research has involved two main approaches: (1) surveys of pastoral households and monitoring animal throughput and prices at local markets; and (2) surveys of traders and other persons involved in regional livestock marketing networks. Research on the efficacy of rural financial systems implemented by the Kenya Rural Enterprise Program Development Agency (KDA) in northern Kenya has been conducted using survey methods to analyze the performance of several rural financial service associations (FSAs) in northern Kenya. How conflict is stimulated by competition over natural resources has been the subject of research in southern Ethiopia.

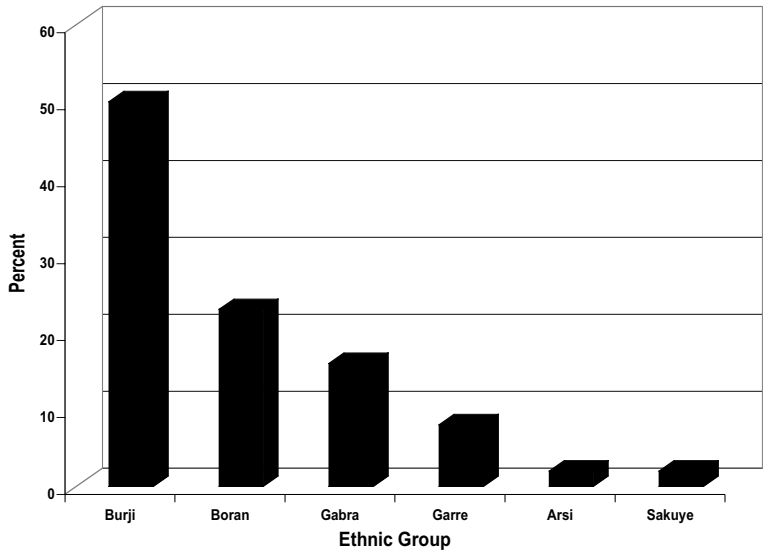
Progress. Monitoring local markets to record livestock transactions is ongoing. The analysis of trading networks was recently completed as part of a doctoral dissertation. The work on livestock trading networks addresses key social mechanisms and risk management strategies utilized in the cattle trade of northern Kenya and southern Ethiopia.

Figure 5 - Cattle exports (head per year) from Moyale to Nairobi, 1991 to 2001.



It highlights the significant role that trust and social relations play in minimizing risks for traders, in particular. This study also traces the movement of livestock from southern Ethiopia to Moyale, Kenya, and on to Nairobi, Kenya's largest city and largest urban beef market. Cattle numbers traded between Moyale and Nairobi have been very dynamic in the past decade, from a low of nil in the mid-1990s to over 40,000 head per year starting by 2000 (Figure 5). In their efforts to reduce risks, traders act individually and collectively and, consequently, form risk-reducing mechanisms both at local and regional levels. These arrangements not only curb recurrence of trading risks, but they also help to improve cattle exchange at all levels of the trading chain and thereby enhance livelihood systems of businessmen and other market actors. Cattle traders in northern Kenya find it increasingly necessary to forge trading partnerships and establish networks to reduce trading risks. Results show that cattle trading in the study area is highly personalized at the upper levels of the marketing chain (in Nairobi) because of increased risk. This study contributes to the discussion of partnerships in market exchanges and departs from previous studies by emphasizing seller-seller relationships as opposed to buyer-seller relationships. While the latter relationships are important in the market, the former strategy is used to minimize risks among traders. This research also revealed that the ethnicity of a trader is one of the major markers that distinguish cattle participation in the study area. While most traders in southern Ethiopia are predominantly Boran (90%), the majority in northern Kenya are Burji (50%; Figure 6). Cattle merchants also have tremendous language abilities and most of them can converse in at least three different languages. Among northern Kenyan merchants, language ability determines where a trading partner is based. Generally, trading partners capable of English and Kiswahili are based in Nairobi to reduce the language barrier between northern traders and Nairobi-based cattle wholesalers and butchers. Working with trading partners helps to reduce the kinds of risks shown in Figure 7. There is a correlation between the existence of partnerships among traders and

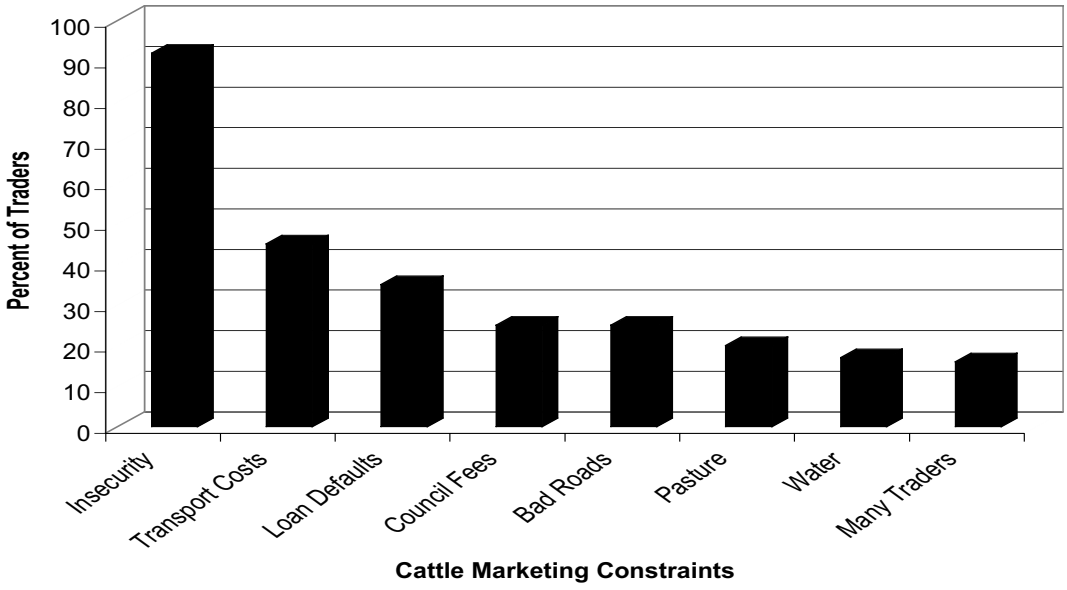
Figure 6 - Ethnic composition of cattle traders in northern Kenya (N=62).



the rate of loan defaults—loan defaults are a major problem for traders. In a sample of 35 traders, we found that the rate of default ranges between 2 and 26%. The average rate of default for traders with partnerships is 5%, while those without partnerships experienced a higher rate of default at about 9%.

Understanding Resource Conflict in East African Rangelands. Using data collected in a supplementary module to the PARIMA quarterly household surveys in Finchawa, Dida Hara, Dillo, Dirib Gombo, Suguta Marmar, and Ng'ambo, we studied inter-household conflicts over water and land resources. We tested three hypotheses: (1) that resource-related conflict is frequent and widespread; (2) that resource-related conflict is more likely for households having bigger herds because their resource requirements are greater than those of households with smaller herds, leading to greater competition and frequency of conflict; and (3) that resource-related conflict arises due to changes in land use patterns that may be unrelated to patterns of herd accumulation or

Figure 7 - Major cattle marketing constraints in northern Kenya and Nairobi (N=71).



stocking densities. Preliminary findings (Table 3) suggest that resource-related conflicts are infrequent. Less than half (46%) of surveyed households had been involved in any resource-related conflict in the past decade, and half of those experienced two or fewer such conflicts over the preceding ten years. Resource conflict occurs frequently for only a small number of pastoralist households. Most conflict is over land, not water. Where conflicts occurred, preliminary results of our econometric analysis indicate no statistically significant link between a household's livestock holdings and its expected incidence of conflicts. Rather, resource conflicts over land or water were more likely to occur in communities characterized by diverse and rapidly changing resource use patterns associated with sedentarization and relatively recent introduction of crop cultivation. Pastoralist mobility to satellite camps appears to dampen the likelihood of conflicts involving land and water, further suggesting that traditional pastoralism is less prone to resource-related conflict than transitional systems, although we cannot say anything about the violence involved in these conflicts. Separate multinomial logit regression analysis of whether or not conflicts were resolved and, if so, how, reveals that traditional methods of resolving relatively less violent inter-household resource-related conflicts appear to remain viable, particularly in communities where pastoralism still dominates.

These highly preliminary findings underscore the importance and viability of indigenous resource management and conflict resolution mechanisms in pastoral dominated areas. Widespread assumptions that pastoralism fosters resource-related conflict, or that increased herd sizes inevitably fuel resource competition and therefore violent conflict over land, appear debatable. Rather, due to the inherent spatio-temporal flexibility of pastoralism, mobile herders seem relatively able to avoid conflict and to manage it when it does occur more effectively compared to other, more sedentarized communities that increasingly rely on crop cultivation and the non-agricultural economy, and for which effective community-based resource allocation rules and dispute resolution mechanism may not yet have evolved.

Table 3 - Extent of resource-based conflicts during the last ten years for a selection of communities in northern Kenya and southern Ethiopia.

Type of Conflict	Sampled Households (%)	Average Number of Conflicts (for those who experienced conflict)*
Cultivator-Cultivator conflict over land	20.6	2.2 (2.10)
Cultivator-Cultivator conflict over water	3.1	3.0 (2.92)
Herder-Herder conflict over land	15.0	4.6 (4.12)
Herder-Herder conflict over water	9.4	1.9 (2.34)
Cultivator-Herder conflict over land	15.0	2.0 (1.84)
Any one of the above conflict types	45.6	3.8 (4.41)

*Figures in parentheses are standard deviations

Activity Three: Training African Graduate Students at Egerton University

Problem Statement and Approach. The objective of this activity is to educate African graduate students in the area of pastoral risk management, with research and academic support provided by an African institution, namely the Faculty of Environmental Studies and Natural Resources (FESNARE) at Egerton University in Kenya. Overall, Egerton students have heavily relied on structured surveys, key informant interviews, and focal group discussions in their projects.

Progress. This has been an important year for this activity, as five master's theses have been recently published. Work by master's students including Mr. Moses Esilaba, Mr. Clement Lenachuru, and Mr. John Tangus has been summarized in GL-CRSP Annual Reports 1999-2002. The graduation of Esilaba, Lenachuru, and Tangus benefits Egerton University, as they will assume staff positions in the Department of Natural Resources at FESNARE. Mr. Uma has rejoined the Oromia Cooperative Promotion Bureau (OCPB) in Addis Ababa, Ethiopia. Three more students are currently in the pipeline at Egerton. Fieldwork for the doctoral project by Mr. Abdullahi Dima Jillo is nearing completion. His work broadly deals with resource use and conflict mitigation among the Waso Boran of northern Kenya, and the dissertation should be submitted by the end of 2004. Two additional Kenyans were matriculated at Egerton in the past year. Their objective is to study the risk of losing key ecological resources at different spatial scales in Baringo District. Mr. Nicholas Olekaikai is undertaking a master's project, while Mr. Mark Mutinda is undertaking a doctoral project.

Here we highlight work by Lenachuru and others that has been prepared for peer reviewed publication. It examines growth in formal education among the Il Chamus of Baringo District, Kenya, and builds on research conducted during the early 1980s. About 35% of households studied in 2000-02 were either the same or direct descendants of household heads included in work during 1980-81. While there are disadvantages in comparing two "snapshots" of a community in the absence of panel data from an identical sample of households, there are strong similarities between the two periods that make such a comparison useful. In both 1980-81 and 2000-02 the Il Chamus experienced major die-offs in cattle—in excess of 70% in both cases. The years 1980 and 2000 represent two of the most devastating droughts of the past 50 years, while 1981 and 2001-02 were both herd rebuilding years. Because of the rapid growth in access to public education during the past two decades, it was possible to explore whether increased education access has improved human welfare, and if so, for whom. Another important question is the extent to which education has allowed herding households to better manage risks through income and asset diversification.

Table 4 illustrates the extent to which education has increased in the area during the past 20 years. The data indicate major differences in education patterns between the two time periods. For example, the percent of household members who have attained "some secondary education" increased about three-fold between 1980 and 2000. Those who attained some post-secondary training (at either a teacher training college or university) also grew from nil in 1980-81 to about 4% of total household members in 2000-02. School attendance by females grew about six-fold from 0.2 members per household in 1980-81

to 0.9 and 2.0 in 2000 and 2002, respectively (Table 5). Overall, the number of children per household who attended primary and secondary school increased from 0.7 to 2.2 and 3.3 during 1980-81 and 2000-02, respectively. In 1980-81, 46% of households had at least one household member in school, while in 2000, 77% of Il Chamus households had at least one child in school. In 2000-02 more than 80% of children between 8 and 14 years of age were in school, while this figure was less than 25% in 1980-81.

One indicator of measuring education's impact on local livelihoods is to examine whether or not it has affected employment patterns. In open-ended interviews in 1980-81 and 2000, almost all individuals emphasized the employment benefits of increased education—education brought more secure incomes from "good" types of waged employment, like government jobs or teaching. How has increased education among the Il Chamus affected employment and, indirectly, household welfare? Table 6 confirms changes in employment patterns, as well as changes in the average number of years of education per household member, across the two time periods. There is little doubt that "regular" wage employment has grown tremendously from 1980-81 and 2000-02. By 2000-02, at least 20% of households had a member with a regular wage, in contrast to 8 to 11% having the same in 1980-81. What is hidden in these data is higher-paying employment attained in recent years. While in 1980-81 only 15% of households with a

Table 4 - Changes in education indicators for an Il Chamus community from 1980 to 2002.

Data Source	Total Sample of Household Members	Household Members Having Post-Secondary (PS) Education	Household Members Having Some Secondary (S) Education	Household Members Having Secondary and Post-Secondary Education (PS+S)
PARIMA Baseline (2000)	223	8 (3.6 %)	19 (8.5 %)	27 (12.1 %)
P. Little Repeat Study (2002)	103	5 (4.9 %)	7 (6.8 %)	12 (11.7 %)
Lenachuru Study (2000)	198*	29 (14.6 %)	20 (10.1 %)	49 (24.1 %)
BPSAAP Study (1981)	593	1 (0.2 %)	16 (2.7 %)	17 (2.9 %)
P. Little Original Study (1980-81)	299	None	10 (3 %)	10 (3 %)

**Only included household heads. Note that 2% of those having post-secondary education attended university.*

Table 5 - Average number of Il Chamus children in formal schools, 1980 - 2002.

Data Source	Male Children in School per Household	Female Children in School per Household	Total Children in School per Household
PARIMA Study 2000-02 (n=30)	1.23	0.93	2.17
P. Little Repeat Study 2002 (n=13)	1.31	2.00	3.31
P. Little Original Study 1980-81 (n=56)	0.52	0.16	0.68

member having a regular waged position worked outside of Baringo District, this number increased over three-fold to 50% in 2000-02. Non-pastoral income derived from improved access to education has clearly aided Il Chamus households in Baringo to better cope with drought. Investment in education is a key diversification strategy that allows herders to better cope with vagaries of drought and other economic shocks. While there have been increased investments by herders in small businesses, land, and other assets, education has probably been the key investment other than livestock.

Activity Four: Project Regionalization

Problem Statement and Approach. The objective of this activity has been to extend the influence of the PARIMA project beyond our study region of northern Kenya and southern Ethiopia in terms of a sustained field presence. We specifically wanted to include the Livestock Production Research Institute (LPRI) in Mpwapwa, Tanzania. The concept was to replicate the community-based action research model that has been underway in southern Ethiopia since 2001 (see GL-CRSP Annual Reports for 2001 and 2002).

Progress. We have reconsidered this activity in 2003 in light of funding constraints and limitations of staff time. We feel unable to make a large enough commitment to this activity to make it truly effective. Instead, we have decided to pursue regionalization more in the context of electronic dissemination of information, strengthening cross-border linkages between the Kenya Agricultural Research Institute (KARI) and the Oromia Agricultural Research Institute (OARI).

Activity Five: Outreach and Action Research

Problem Statement and Approach. The main objectives of this activity are to: (1) build capacity among pastoralists, development agents, and policy makers to better appreciate and implement pastoral risk management interventions; and (2) document best-bet community led projects using monitoring and evaluation protocols. The focus is on the Borana and Gugi Zones of southern Ethiopia, with cross-border activity extending into the Moyale and Marsabit Districts of northern Kenya. The USAID Mission to Ethiopia funded roughly 85% of this activity in 2002-03. For a review of the original five community-led risk management pilot projects in southern Ethiopia that were initiated in 2000, see the GL-CRSP Annual Report 2002.

Progress. For capacity building we sponsored or co-sponsored over a half-dozen key events. In chronological order, these

Table 6 - Education levels and household members with regular wage earners during 1980-81 and 2000-02.

Data Source	Sample Size (Households)	Average # of Years of Education per Household Member	Percent of Households Having a Regular Wage Earner
A. PARIMA Baseline 2000	30	3.53	20
B. Peter Little Repeat Study 2002	13	3.94	31
C. Combined A. & B. above	43	3.65	28
D. Lenachuru Study 2000	198	Not Available	26
E. Peter Little Original Study 1980-81	56	0.76	11
F. BPSAAP Survey 1981	78	0.93	8

included: (1) the Third Cross-Border General Workshop for Ethiopia and Kenya, held as one in a series of meetings to seek grass-roots means to better harmonize cross-border relations, build peace, market livestock, and re-establish reciprocity in natural resource use. Ninety participants (including pastoral leaders, development agents, and policy makers) met for two days at the SORDU compound in Yabelo, Ethiopia, during mid-December; (2) a 3-week tour for five leaders of successful women's groups from northern Kenya was held for them to meet and inspire Ethiopian pastoral women across the Borana Plateau. Over 600 Ethiopians attended four venues between mid-December to early January where the Kenyan women spoke and answered questions; (3) a steering committee meeting for the Ethio-Kenya Cross-Border Initiative was held in Moyale, Kenya, in mid-February. Twenty-six participants met for two days to plan future cross-border activities; (4) two loan-disbursement cycles were conducted for 175 members of the new Dida Hara savings and credit association as part of an action research project; (5) Eight representatives of two community projects were taken on a four-day tour of livestock marketing and processing facilities in Modjo, Debre Zeit, and Addis Ababa in an effort to better link pastoral producers with the livestock trade industry; (6) twenty-eight representatives of community projects were taken for two-day exchange visits across the Borana Plateau to view pilot risk management activities in other locations and bring new ideas back to their home areas; and (7) expansion of community-led projects to include new risk management activities at Finchewa and Dubluk, as well as a doubling of the size of the previous activity at Dida Hara.

Action research is a sequential process of problem identification, constraint alleviation, and documentation of progress for community-led risk management pilot projects. This research component has several dimensions. For example, the performance of 115 households is being evaluated on a quarterly basis across five pilot projects in terms of their success in undertaking new micro-enterprise activities to diversify income. Another 175 recipients of loans in the Dida Hara Savings and Credit association and over 100 participants in a non-formal education activity are being monitored for their achievements. Effects of the cross-border women's tours on building-up women's groups and spurring innovative behavior in Ethiopia are being documented. All monitoring and evaluation is being conducted in partnership with GO and NGO organizations.

Research Observations from Selected Pilot Intervention Projects. The need for Borana pastoralists of southern Ethiopia to engage in some aspects of economic diversification has been previously mentioned in GL-CRSP Annual Reports (1998-2002). Periodic and massive death losses of livestock—due to high stocking rates in combination with low rainfall—have been documented. These mortality spikes represent large economic losses to Borana society and risk management strategies are needed to assist pastoralists to help mitigate increasing poverty and food insecurity in the presence of weak marketing channels and limited development opportunities. One approach has been to encourage the Boran to diversify investments to include non-livestock options, at least on a small scale, and hence promote alternative forms of income generation and wealth conservation. The viability of such diversification has important implications for pastoral development strategies and environmental management. Here we report observations from a series of community-

driven pilot intervention projects begun in 2000. Semi-settled pastoral communities were surveyed using bottom-up, open-ended assessments of community needs using participatory rural appraisal (PRA) techniques. Communities used this process to identify priority interventions to be implemented in partnership with a local development agent. A review of preliminary results for five pilot projects indicates that these communities—located near rangeland towns—prioritize interventions focused on savings and credit associations, micro-enterprise development, and non-formal education. These are self-help activities that communities feel they need in order to tackle problems like food insecurity (i.e., by increasing income to purchase food) and to overcome restricted access to formal education. Women's groups are prominent leaders in adopting innovations, and progress over the past 18 months has been remarkable. We are only in preliminary stages of tracking induced change in this system, and the implications of small-scale economic diversification for livestock management and the local ecology have yet to be clarified. Our experience to-date, however, confirms that risk-management interventions appear to be in demand here. We have also observed a high level of enthusiasm within pastoral communities when they are given the opportunity to lead development initiatives.

Five pilot projects have been implemented since 2000. Pilot project No.1 consists of the establishment of savings and credit groups among Borana pastoralists in the Dida Hara region, with a total membership of 175 men and women. Pilot project No.2 is a non-formal education project, also among the Boran at Dida Hara with a total enrollment of 187 children and adults. Pilot projects No.3 and No. 4 consist of two women's groups near the town of Negele. One is involved in micro-enterprise development while the other is a savings and credit scheme. The total membership for these projects is 254 women. Pilot project No.5 is another women's group with a focus on development of micro-enterprise and savings and credit capacity in the vicinity of Moyale town on the Ethio-Kenya border. This project has a total membership of 44 women. Below we focus most of our discussion on the two pilot projects in Dida Hara.

Based on the outcome of the PRA ranking exercises, problems identified by the Dida Hara community—in order of importance—were: (1) lack of food; (2) lack of water; (3) lack of access to education; (4) poor human health; (5) poor livestock health; and (6) lack of marketing and economic diversification. Among the mentioned root causes of food insecurity was the low level of livelihood diversification, both at the household and community levels. The result of the option assessment exercise in the PRA revealed how the community thought it might deal with food insecurity using their own resources. Options included: (1) improved agronomic practices; (2) better organization of livestock marketing cooperatives; (3) establishment of savings and credit institutions; (4) promotion of alternative income-generation activities; and (5) micro-enterprise development. Similarly, introduction of non-formal education was on the top of the list of options to alleviate the problem of poor access to education. The Community Action Plan (CAP) derived from the PRA for Dida Hara was developed based on further discussions of the ranked problems, the options available to solve the problems, and the capacity of the community in terms of local resources and knowledge to implement potential solutions. The CAP formed the basis for the creation of the two pilot projects.

A local NGO called Action for

Development (AFD) assisted the community in the preparation of both proposals, for funding consideration by the ORP. One of the projects in Dida Hara was aimed at promoting a savings and credit institution and micro-enterprise development for expanding the income-generation opportunities for local communities and to contribute to their capacity to better cushion themselves from shocks. The association of savings and credit with development of small-scale business activity appears to be related to the need for income generation to allow people to buy food. The direct beneficiaries of the project are 175 pastoral households, of which 58% are women. The institutional arrangement for the implementation of the project primarily involved the local community, AFD, and PARIMA. The local office of the Oromia Cooperative Promotion Bureau (OCPB), the Oromia Agricultural Development Bureau (OADB), and other relevant government authorities were brought on board to be an integral part of the effort.

The process of savings and credit group formation started with the creation of primary groups comprised of five to seven people. An average of five primary groups then formed secondary groups having 35 to 49 members. The members of the groups started with periodic savings based on bylaws of each group regarding amount and frequency. Emphasis was put on encouraging members on the need to mobilize local resources and to develop a savings culture. Group members were expected to mobilize sufficient savings before commencing on a program of loan extension, as we have pursued a savings-led approach.

The first loans were disbursed in March 2002 to 90 members of the Dida Hara savings and credit group. Forty-five percent of loan recipients were females. The loan term was six months. The average size of each loan was Birr 660 (or USD $82) per applicant. It was found that all those who had taken a loan made a profit of Birr 500 (USD $62) on average, and this enabled all recipients to pay back the loan principal along with the interest of 10.5%. The loans were invested in a wide variety of activities. About 18 loan recipients (19% of the total) were involved in livestock trading or petty trading, with the remainder (81%) involved in cattle and goat fattening (growing). For the latter activities, animals were bought before the start of the rainy season in March, and allowed to grow and fatten when forage conditions were good during April, May, and June. Animals were then sold early in the dry season. A second loan amounting to Birr 81,600 was disbursed in a similar manner for 85 members who had been waiting for the repayment of the first loan to get their chance. The loan size for each recipient was raised to Birr 900 (USD $112) for some recipients and Birr 1,000 (USD $125) for others based on their level of savings. Seventy percent of the recipients of the second round loan were females.

During the first year of the activity, a total savings of Birr 24,688 (or USD $3,100) was achieved across the 175 members of the savings and credit groups at Dida Hara. The approach employed by AFD has a variety of built-in mechanisms to enhance system performance. These focus on peer pressure. The group rises or falls depending on the performance of each individual. The focus on savings mobilization and savings-led credit disbursement appear well-founded to us. Loan recipients were selected based on criteria such as credit worthiness, ability to engage in the business of their choice, and possession of savings amounting to at least 10% of the borrowed amount. The loan procedure adopted at Dida Hara involves a loan

application to the applicant's primary savings and credit group and preliminary appraisal of the application by the primary group. If the review is positive, the application is forwarded to a secondary group for further deliberation. Disbursement of a loan will occur only if the secondary group also approves the application. The loan ceiling is determined by the availability of resources, the amount of savings, and the type of project. The PARIMA project and implementing agencies regularly monitor and document loan repayment, loan use, profits earned, losses incurred, etc. The group members participate in the monitoring and evaluation process.

The second pilot project in Dida Hara is a non-formal education (NFE) project, which began in 2001. The project was an education intervention mainly aimed at creating an enabling environment for adults, school-age children, and dropouts to have access to basic education through establishment of community education centers. There was only one formal primary school (grades 1– 4) with three teachers in the 2000/01 academic year in the vicinity of Dida Hara. School enrollment was only 195 pupils (148 males and 47 females) in 1999/00 and 291 pupils (217 males and 74 females) in 2000/01 academic years (Yabelo Wereda Education Office, unpublished data). Female participation was typically low. This was from a potential local population exceeding 10,000 people.

The non-formal education project was designed to provide an organized, systematic educational activity carried on outside the framework of the formal system. It provides selected types of learning to particular sub-groups (adults and children). The project was gender-sensitive by giving special attention to the enrollment of females. The community used locally available materials to construct two school buildings within pastoral settlements. The institutional arrangement for implementation of the project involved local community organizations, AFD, PARIMA, and the Oromia Education Bureau at various levels, as well as other local authorities.

Rapid progress has been achieved with the non-formal education activities in the two centers (AFD, unpublished data). The flexible scheduling approach has helped instruction to occur in three shifts per day, which led to excellent attendance. The overall results indicate an increasing level of literacy and numeracy among school attendees. Almost all students (58 females and 129 males, including adults and children) attending the NFE have achieved a rudimentary level of literacy and numeracy within six months. This allows them to track figures in their savings and loan booklets.

Three other women's groups dealing with savings and credit and micro-enterprise development are located near Moyale and Negele towns. Moyale is a border town with a moderate population (ca. 15,000) and is important for livestock marketing in the region. Negele is the largest town in the Borana plateau with a population of 25,000. All three of the projects had to go through the process of participatory needs assessment to generate information required to prepare proposals for ORP review and PARIMA funding. The two groups in Negele have a total of 256 members with a total savings to-date on the order of Birr 24,760 (partial data only). The 44 women in the Moyale group have saved Birr 7,450 during the first phase of the activity.

The lead institutions assisting these communities in planning and implementation of the projects are the OCBP and the OADB. The NGO Save the Children USA (SC/USA) collaborates with these institutions to

implement the women's dairy group in Negele. All the women's groups have performed very well to mobilize savings and start small group business activities. All these groups are involved in small-scale businesses using their own resources. Trade involving petty commodities and livestock has dominated business activities. Moreover, the groups have extended loans to individual members and helped them to initiate their own businesses to augment their income.

In order to build capacity among project participants to deal with issues pertaining to rural finance and small-scale business development, PARIMA has facilitated training and tours for selected members. A seven-day training course offered by the Fura Institute of Development Studies (FIDS) was given during 2001-02 for 31 people including 27 members of pilot projects (20 women, seven men, and four development agents). The course concerned small-scale business development and management. The participants were drawn from four locales [Negele with 11 participants, Dida Hara (11), Moyale (5), and Finchewa (4)]. The training program devised by FIDS was specifically designed for illiterate people, being based mainly on group discussion. Participatory learning tools were used to stimulate group interactions. Participants were able to review and analyze their understanding of business management. Prior to the training, selected pastoral women from the various groups made a cross-border tour to meet successful women's groups in northern Kenya. The tour participants gained much experience on how to set goals and plan and implement various development activities. These activities include rural financial institutions, small-scale businesses, and lobbying the government and potential donors.

The overall goal of PARIMA's interventions is to develop a sustainable approach for risk-management intervention that will help empower pastoral communities to conserve wealth and diversify their income and assets away from a sole focus on livestock over the longer term. We believe this can strengthen their livelihoods to better cope with droughts, food insecurity, and chronic resource restriction. It may also have ramifications for the condition of the rangeland environment, especially if the people have an opportunity to sell less-productive stock before drought impacts are manifested and use the revenue to support viable alternative investments—this option also depends on viable market channels. We hope to follow progress of the pilot projects for a few more years to observe to what extent sustainable diversification and changes in livestock and resource management occur as a result of these interventions. At present our interpretation of why communities select rural financial and educational interventions is so they can better position themselves to generate more income to buy basic necessities, prominent among which is food. These choices may also represent a process of self-empowerment. Although it will take time before the ultimate outcomes of the pilot projects become apparent, we have learned a lot over the past 18 months. Perhaps the greatest lesson so far is that a true participatory approach can unleash a tremendous amount of energy and enthusiasm for positive change, even in a pastoral setting. The pilot interventions are all based on giving communities the opportunity to lead on problem identification, project design, and project implementation. We have also seen that, with appropriate technical oversight and training, people such as the Boran at Dida Hara—who have little formal education—appear quite capable of implementing small-

scale activities dealing with rural finance and income diversification. Human capital development, in the form of intensive training and exchange tours for project beneficiaries, promotes sustainability of interventions. We have also witnessed the high operational effectiveness of pastoralist-to-pastoralist extension modes that contribute to rapid transfer of knowledge and skills. The approach pursued by PARIMA to implement its program in partnership with local development organizations also promotes continuity of effort when PARIMA phases out. The action research carried out by PARIMA to help monitor and document intervention outcomes can help guide larger development initiatives in the future. There has been a decided lack of such documentation of local pastoral development experiences in the past.

Research Observations from a PRA Exercise at Kargi, northern Kenya. Inadequate quantity of water is a common problem for pastoral people in East Africa. For the Rendille community of Kargi in northern Kenya, however, water quality has also been identified as a critical issue in a PRA exercise conducted in 2000. Residents report that water-borne diseases commonly affect human health in dry seasons, and livestock may die soon after drinking water from some of the older, deep wells. Kargi was a single water point in the 1920s, but started to become a small town by the early 1970s when Rendille nomads settled. Kargi now has about 5,700 people living under difficult conditions that include a lack of infrastructure, high levels of illiteracy and physical insecurity, and prevalence of drought. In the past 30 years some 20 wells have been dug in and around Kargi, but today about seven remain fully functional in terms of adequate water flow or minimally acceptable water quality.

As a first step to address water quality problems at Kargi, we embarked on a partnership with the Sustainable Management of Watersheds (SUMAWA) project of the GL-CRSP. We decided to analyze water samples from five key water points for physiochemical and bacteriological features during April 2002. We followed standard procedures. Water samples were taken from a number of sources. Some were collected from two centrally located wells (called Kargi and UNESCO Wells) that are up to 9 meters deep and over 50 years old. The rest were collected from two younger, shallower wells (called School and Hadad) and an earthen dam (called Kuya) that accumulates surface water. In contrast to the two old wells, these three other water points are located further from the core settlement zone of Kargi.

Preliminary findings indicated that water quality from the older wells was very poor in both physiochemical and bacteriological features. Results for selected parameters are shown in Table 7 along with technical quality guidelines from ACCC (1999). Particularly notable are the very warm temperatures of well water (due to residual volcanic influences), the high mineral content of water, and presence of toxic microbes. Microbes included fecal coliforms, *Salmonella spp*., *Escherichia coli*, and possibly *Shigella spp*. It was speculated that ambient conditions in the old wells could be conducive to the manufacture of hydrogen sulphide gas (H_2S), a potentially lethal compound produced by Salmonella microbes when oxygen concentration of water is low and free sulphur is abundant. This could explain livestock mortality risk after drinking well water, but requires further investigation. Low oxygen concentrations in well water can be promoted by warm water temperatures and restricted aeration. The water quality from the younger wells and the Kuya Dam was a bit

better compared to that of the old wells. Although salinity and total mineral content was often high for the School Well, only a trace of Salmonella was detected in bacteriological analysis. Blooms of blue-green algae (Cyanobacteria) were also visually noted on the walls of the School Well, and some species of this microbe family can be toxic. The younger wells and Kuya Dam exhibited evidence of fecal contamination from coliform bacteria, even though presence of E. coli and Salmonella spp. tended to be lower than values for water from the old wells (Table 7).

This work has several practical implications. Water quality for the old Kargi and UNESCO Wells is very poor for human—or even livestock—consumption. One factor that contributes to this situation is probably the central, physical location of these wells in relation to the town and low position on the landscape. Rare but severe rainstorm events could help funnel human and animal waste into the water supply for these wells. It is doubtful whether the water quality from these old wells could ever be restored to meet minimum standards for human consumption. Catchment systems could be constructed that would help channel waste water away from the aquifers serving the old wells. Water intended for livestock consumption could be drawn from these wells and left to stand overnight in open troughs to allow evaporation of potentially toxic gases like hydrogen sulphide. Water quality from the younger School and Hadad

Table 7 - Selected water quality values from samples collected at Kargi, northern Kenya, during April 2002[1].

Parameter	Kargi Well	UNESCO Well	School Well	Hadad Well	Kuya Dam
Temperature	32.0*	31.5*	32.7*	32.8*	29.5*
pH	9.6*	9.2*	9.2*	9.5*	11.5*
Salinity	<2.5	<2.5	17.5	<<2.5	<<<2.5
Hardness	1,159**	1,572**	574*	292	70
Sulphates	941**	2,587**	3,528**	470	T
Coliform	70	0	30	700	40
E. coli	+++	+++	-	+	-
Salmonella	+++	+++	+	+	+

[1]A total of 23 parameters were evaluated. Analyses followed procedures of APHA (1992). Temperature is in degrees centigrade; pH is a measure of acidity with tabular values indicating non-acidity (base) levels; salinity was measured in salt grams per liter; hardness was measured in terms of milligrams of calcium carbonate per liter; sulphate content was measured in terms of milligrams of sulphur per liter (with T as trace); fecal coliform was measured in terms of concentration of bacteria per milliliter; E. coli and Salmonella bacteria were measured as clearly present (+++), likely present (+), or absent (-) using laboratory bacteriological assessments.

Asterisks indicate either high (**) or slight to moderate (*) variation from ACCC (1999) guidelines for domestic water. Guidelines for salinity are not given. Bacteria (fecal coliforms, E. coli, Salmonella) are not supposed to occur in domestic water under any circumstances.

Wells and the Kuya Dam was somewhat better compared to that from the old wells, and validates why these water sources tend to be highly valued by the community. The improved condition of these water resources is probably related to factors that include the physical location of these water points and attention given to excluding animals from the immediate vicinity. The younger wells and Kuya dam are located away from concentrated human settlement. The Kuya Dam, in particular, is protected by a strong thorn fence to keep animals out. This also helps keep animal waste from collecting in the vicinity. The presence of fecal coliforms at each of these locales, however, means that the community must still be vigilant.

The community could be trained to monitor water quality using simple test kits and hence have an early warning system to detect problems before they overwhelm the system. While the high mineral content of water in general appears to be a given due to geology and is not amenable to improvement, a simple system for "pot chlorination" could be implemented to eliminate dangerous microbes, especially at the younger wells having smaller water volumes. That such microbes pose community health risks is an understatement. Microbes such as fecal coliforms are associated with diarrhea, vomiting, and dehydration.

Shigella spp. can be associated with dysentery. Strains of *E. coli* are associated with acute systemic poisoning, and chronic exposure can lead to permanent health complications. *Salmonella* is a genus that leads to a variety of very debilitating ailments including typhoid fever, arthritic-like joint diseases, and severe diarrhea. Death can occur from any of these challenges.

Conventional wisdom in pastoral development focuses on the need to deal with priorities such as drought, poverty, livestock management, marketing, ecological degradation, loss of key resources, and physical insecurity. While water has traditionally been viewed as a major constraint for pastoral livestock production and the balanced use of extensive forage resources, insufficient attention has been given to the problems of water quantity and quality for increasingly settled populations of pastoral people living under conditions of high human concentration and limited infrastructure. While comprehensive surveys of water quality and human health have yet to be conducted throughout pastoral areas in East Africa, we suspect that problems of water quality, like those observed at Kargi, are probably increasingly common.

Activity Six: Collaboration between PARIMA and LEWS on Understanding Determinants of Pastoral Livestock Off-take During Drought

Problem Statement and Approach. One of the goals of the Livestock Early Warning System (LEWS) project of the GL-CRSP has been the prediction of livestock supply to market during times of drought. The LEWS project has sought to refine predictive models for climate patterns and livestock performance so that they could be applied as tools for providing decision support to stimulate animal off-take during early stages of a drought. For example, climate predictions from regional forecasting centers can be used to convey the likelihood of inadequate seasonal rainfall in our study region. If this information could be adequately conveyed to pastoral producers, it is thought that producers could take pre-emptive action by de-stocking in anticipation of a failure of a rainy season. Early de-stocking could allow households to take

advantage of more favorable pre-drought prices, reduce drought-related mortality losses, and relieve pressure on natural resources. Other tools to aid this decision-making process include models that predict forage production as a result of precipitation and those that predict livestock nutritional status as a function of the quantity and quality of forage. Given insights into anticipated patterns of forage yield and livestock production, pastoralists and traders could be further compelled to engage in pre-emptive de-stocking and other related adjustments. Work of the PARIMA project complements these objectives in several respects. First, the PARIMA project is interested in the actual factors that influence how pastoralists make decisions to sell animals. For example, favorable prices may be a key determinant, as could the need to buy non-pastoral food. Conversely, if pastoralists have few alternatives to storing wealth as livestock, it is rational for them to hold all of their animals and hope that providence spares them and they will survive a drought unscathed. This logical traditional rationale may be becoming harder to justify as fall-back resources dwindle, human populations increase, and local resource degradation intensifies. In addition, if market infrastructure is lacking, there may not be opportunities for many pastoralists to sell stock in anticipation of drought even if they wanted to.

One goal for the joint PARIMA-LEWS activity, started in 2001, is to clarify decision-making processes regarding livestock sales behavior. This is to be determined using household level surveys that test a series of alternative hypotheses as to what most motivates households to dispose of animals. Another goal is to collaborate on geo-referencing households and market infrastructure from both the PARIMA and LEWS data sets for northern Kenya and southern Ethiopia. It is thought that once decision rules are better understood, and the extent to which marketing features influence the flow of stock to terminal markets is clarified, that spatial explicit predictive models can be developed. These models would then attempt to predict the supply of animals to market given extant environmental and economic conditions. The models can be parameterized to account for how flows of animals might change in response to changes in information access, price structures, and infrastructure improvements. This would permit sectoral-level analyses whereby the costs of pastoral marketing and information investments could be compared with the benefits of increased sales, pastoral household well-being, and other ripple effects in the regional livestock economy.

Progress. Early in this fiscal year PARIMA scientists completed data collection across the Kenya sites (i.e., Suguta Mar Mar, North Horr, Marigat, and around Marsabit Mountain) regarding household-level livestock marketing behavior. This work has been based upon structured questionnaires and adds more detailed data on aspects of livestock sales, purchases, and transfers as recorded in the quarterly repeated surveys (see Activity 1). This work also parallels a market-level instrument fielded in December 2002, wherein the team is sampling transactions in principal livestock markets serving our study region in northern Kenya and southern Ethiopia. These two data sets will enable us to provide a more accurate description of livestock pricing and market behavior and test alternative hypotheses for pastoral livestock marketing incentives implicit in the PARIMA-LEWS module. In the second half of the last fiscal year the survey data have been cleaned and analyzed. The LEWS team has completed a geo-referenced template of households,

markets, and other infrastructure for the study area that will serve as a spatial modeling framework.

As part of the PARIMA-LEWS joint module, we collected household-level survey data and have undertaken market monitoring to collect transactions-level data in Marigat, Marsabit, North Horr, and Suguta Marmar markets so as to be able to test a range of hypotheses about pastoralist livestock marketing patterns. We can now report on preliminary econometric results based on a selectivity model to distinguish between households' choice to participate in the livestock market as either a buyer or seller from their choice of net sales (gross sales less gross purchases) conditional upon market participation. We have been able to test the marginal effects of livestock prices, marketing fees, insecurity, quarantine, percentage of initial herd composed of animals encumbered with complex property rights, percentage of initial herd composed of female animals, and having a bank account on pastoralists' decisions to participate in the market as well as on their decision regarding marketed volume. Our preliminary results reveal some clear patterns. Herd size is the strongest predictor of both market participation and of the quantity of livestock marketed among market participants. A larger herd size increases the probability of participating in a market as well as the amount of livestock sold. Insecurity had a statistically significant, positive effect upon the amount of net TLUs marketed as well as on participation in the market, suggesting that in times of insecurity, pastoralists restrict their mobility and increase their use of markets to reduce herd sizes, presumably to compensate for reduced mobility. The percentage of female animals owned had a statistically significant negative effect upon net livestock marketed, suggesting that the greater the amount of females in a herd, the more willing the respondents were to sell their animals. Finally, having a bank account had a positive, though statistically insignificant, effect upon the participation in market decision, as well as a significant, positive effect upon net TLU marketed. Not only does having a bank account render one more likely to participate in the livestock market, it also increases the likelihood of purchasing animals via the market. The direction of causality in this relationship is open to question: do people open bank accounts because they sell animals and need a place to safeguard their receipts or do they market animals because they have access to such accounts? But there does appear to be a correlation, likely reflecting the wealth effect of bank account ownership, as complemented by previous research revealing that a non-trivial proportion of microfinance loans in the study region were intended for livestock purchases.

Activity Seven: Collaboration between PARIMA and ELFORA/MIDROC on Livestock Marketing in Ethiopia

Problem Statement and Approach. The objectives of this activity include clarifying constraints that hinder livestock marketing within Ethiopia, and building a bridge of cooperation between public and private sectors with regards to helping address Ethiopian livestock marketing problems. ELFORA is the agro-industrial subsidiary of MIDROC Corporation in Ethiopia. By the mid-1990s ELFORA/ MIDROC had purchased much of the livestock marketing infrastructure in southern and central Ethiopia that has been previously owned by the Ethiopian government. ELFORA/MIDROC is thus

viewed as a major player in livestock marketing in Ethiopia, especially with regards to the southern rangelands of Borana Zone. We envisioned a public/private partnership with the possibility of PARIMA providing research and outreach linkages that could further assist the development activities of ELFORA/MIDROC.

Progress. Early in this fiscal year a provisional concept note for collaboration was drafted by PARIMA and collaborators in Addis Ababa and given to ELFORA management for review. This included plans for jointly crafting and co-funding a mutually agreeable work plan. ELFORA has experienced changes due to leadership and internal re-organization, however, and ELFORA has not provided a formal response to the concept note. Some other interactions between ELFORA and PARIMA have occurred, however. The outreach tour involving pastoral leaders coming up-country to establish livestock trade linkages included a visit to ELFORA animal processing facilities at Debre Zeit (see Activity Five, above). In addition, a senior staff member of ELFORA attended the recent PARIMA policy maker's meeting in Addis Ababa (see Activity Nine). Our goal therefore is to remain vigilant concerning interactions between PARIMA and ELFORA, but to downgrade this effort from an "activity status" until evidence proves otherwise.

Activity Eight: Interactive Research Visits with Pastoral Communities

Problem Statement and Approach. The objective of this activity has been to communicate synthesized research results to communities where the quarterly repeated survey was conducted, and obtain community feedback that could modify interpretation of the work.

Progress. This effort was successfully carried out for the six sites in northern Kenya during July and August. Research results from the quarterly survey research and ancillary studies (see Activities One and Two) were displayed in culturally appropriate formats and feedback was obtained. Results are currently being written-up. Recent insecurity in southern Ethiopia has required that the similar effort there be delayed until the coming fiscal year.

Activity Nine: Engaging Policy Makers in Kenya and Ethiopia

Problem Statement and Approach. The PARIMA project has successfully held biennial workshops in July 1999 (at the ILRI campus in Addis Ababa, Ethiopia) and June 2001 (at Egerton University in Njoro, Kenya). See GL-CRSP Annual Reports for 1999 and 2001 for a summary of these meetings. The meetings each attracted over 80 participants including researchers, development workers, students, and policy makers. The objective of these workshops has been to disseminate PARIMA information and provide opportunities for other professional interactions. It was intended in the original project proposal (1997-2003) that PARIMA would host a third (and closing) biennial workshop in 2003.

Given the notification in March 2003, however, that the PARIMA project had been extended for another three years, we decided to alter the biennial workshop format to include a greater focus on opening a sustainable dialogue with policy makers in Ethiopia and Kenya. The policy environment in both countries has been exceedingly dynamic the past few years. A new federal system of decentralized government has been implemented in Ethiopia, and a recent change

in the national government has occurred for Kenya. These changes have large ramifications for pastoral development and policy. Thus, despite our delay in opening a focused dialogue with policy makers in both countries, we felt that now was as opportune a time as any to initiate a process of "linking research with decision making."

Progress. Two meetings with policy makers were successfully held on August 8 (Kenya) and August 15 (Ethiopia). Invitees from both countries included key Members of Parliament, Government Ministries, and people representing other governmental and non-governmental (advocacy) organizations. From 30 to 40 people attended each meeting. The one-day meetings consisted of a morning session with invited speakers and an afternoon plenary session to discuss the "way forward." Of the 70 total participants, roughly half were actively involved in policy or decision-making at local, regional, or national levels in both countries. A major outcome of each meeting was the establishment of two locally led provisional working groups concerning policy, governance, and advocacy in the pastoral areas. One group is for Kenya and one group is for Ethiopia. The PARIMA project has a representative within each six-member group to help with coordination and provide secretariat functions. The plan is for each working group to decide on a series of achievable policy-related goals and concomitant terms of reference. The groups can serve as conduits for the PARIMA project to more effectively address how pastoral development decisions are made in both countries. Neither country has a relevant pastoral policy framework—a point raised in both meetings—so there appears to be opportunities for constructive dialogue and possible impact. One proceedings report covering the outcomes for both meetings will be produced in the coming fiscal year.

Activity Ten: Strengthening the Role of African Institutions Dealing with Pastoral Risk Management

Problem Statement and Approach. One of the important aspects of the GL-CRSP is to build capacity among national research organizations, and that is the main objective of this activity. We have already been contributing to this goal in PARIMA by offering formal degree-training opportunities for Kenyans and Ethiopians at the M.S., Ph.D., and post-doctoral levels (see Activities Two and Three). We see other opportunities, however, to build capacity among rank-and-file researchers at the Kenya Agricultural Research Institute (KARI—Marsabit) and the recently created Oromia Agricultural Research Institute (OARI—Yabelo). To this end we wanted to start a process of linking KARI—Marsabit, OARI—Yabelo, and FESNARE (Egerton) to begin a process of cross-border research, training, and collaboration.

Progress. We held three planning meetings for PARIMA, OARI, KARI, and Egerton FESNARE in the past year. These included: (1) A four-day meeting at the KARI Marsabit Station during May to consolidate views from Kenyan partners (KARI, FESNARE) on how best to conduct new collaborative activities; (2) a one-day meeting at OARI Headquarters in Addis Ababa during June to consolidate Ethiopian views on new collaborative activities; and (3) a week-long joint meeting involving KARI, OARI, and FESNARE in Marsabit during July to draft a work plan for 2003-06.

Gender

Gender dimensions of the PARIMA 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 one female scientist on our core team, namely Dr. Cheryl Doss of Yale University. She is an economist. We are studying how risk affects female pastoralists differently from males (see Activity One). 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. For degree training, we are supporting an American woman named Sharon Osterloh at Cornell. For non-degree training we have focused a large component of our outreach on pastoral women's groups (see Activity Five). In our outreach network we have included roughly 52 organizations, with 25 in Ethiopia and 27 in Kenya. Senior women represent nine of these organizations. We initiated a ten-member Outreach Review Panel (ORP) in 1999 that helps guide outreach. There are currently nine members and one third are women. These include Ms. Miriam Cherogony, a Kenyan specialist in rural finance, Ms. Felekech Lemecha, an official with the OARI in Ethiopia, and Ms. Allyce Kureiya, a Kenyan pastoral development specialist working with an NGO in Isiolo.

Policy

Our main goal regarding policy is to have a positive influence on decisions that affect pastoral peoples in Kenya and Ethiopia. We want to achieve this goal primarily through engagement and education of decision makers. We will put a renewed focus on distribution of PARIMA materials (see Activity Four) and getting media exposure where appropriate. We will continue to invite decision-makers to attend meetings, workshops, field tours, and training opportunities, as we have done over the past two years. More policy maker meetings are planned for 2003-04.

Outreach

The Outreach Unit of the PARIMA project has been previously introduced in the GL-CRSP Annual Reports for 2000 and 2001. Funding for outreach has been provided by the USAID Mission to Ethiopia. Current outreach activities have been previously mentioned under Activity Five. The objectives of PARIMA Outreach are to build awareness and capacity of front-line development personnel and pastoral communities to better understand the utility of risk-management interventions and identify best-bet approaches to improve pastoral risk management based on results from pilot interventions and associated research.

Developmental Impact

Perspectives on development impact are similar to those voiced in previous GL-CRSP Annual Reports. These are summarized as follows.

Environmental Impact and Relevance. 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 primarily 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 to 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 U.S. 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 Niño 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 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 by 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. A broadening of our collaborative research role

will benefit KARI-Marsabit (Kenya) and OARI-Yabelo (Ethiopia).

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 is provided to us by ILRI. We have had a link to Dr. Simeon Ehui and the Livestock Policy Analysis Program (LPAP) based at ILRI-Ethiopia. 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 also linked to Dr. Patti Kristjanson, also of ILRI-Kenya. The other CRSP we link to is the BASIS CRSP. Drs. Peter Little and Christopher Barrett, U.S. PIs for the GL-CRSP, and Prof. Abdillahi Aboud, regional PI, are also participants with 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 (2001), 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. Our initiatives in livestock marketing research, and attempting to forge a partnership with ELFORA/MIDROC (see Activities Two and Seven) also are key elements indicating our awareness of the importance of commerce and the private sector. Taken together, these areas of emphasis reflect the functioning of free markets, a role for agribusiness, and developing a capability for pastoralists to empower themselves.

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 doctoral levels. 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 be very relevant to solving problems related to the "human condition" in the study region.

Leveraged Funds and Linked Projects

The value of leveraging for PARIMA during 2002-03 was USD 329,350.00. This is broken out as follows: (1) A total of USD $175,000.00 was contributed by the USAID Mission to Ethiopia for outreach and action research activities in an accompanying project entitled "Improving Pastoral Risk Management and Human Welfare Among Pastoral and Agro-pastoral People: A Pilot Outreach Project for the Southern Ethiopian Rangelands." These funds were channeled through Utah State University and include field operation, PI salary support, and international travel; (2) a total of USD $32,850.00 was contributed by the University of Kentucky. This included travel support for the PI as well as travel and stipend support for graduate students; and (4) a total of USD $121,500.00 was contributed by Cornell University. This included stipends for four graduate students, travel and operating funds from the BASIS CRSP, funds from a grant from USDA/ Rutgers, and funds for food aid research via a Hatch grant.

Training

Degree Training

In progress

Abdullahi Dima Jillo, Ph.D., 2005, Human Ecology, Egerton University, Njoro, Kenya.

Hussein Mahmoud, Ph.D., 2003, Anthropology, University of Kentucky, Lexington, Kentucky, USA.

Mark Mutinda, Ph.D., 2006, Human Ecology, Egerton University, Njoro, Kenya.

Nicholas Ole Kaikai, M.S., 2005, Human Ecology, Egerton University, Njoro, Kenya.

Sharon Osterloh, M.S., 2003, Agricultural Economics, Cornell University, Ithaca, New York, USA.

Amare Teklu, Ph.D., 2004, Natural Resource Science, Cornell University, Ithaca, New York, USA.

Completed

Moses Esilaba, M.S., 2002, Human Ecology, Egerton University, Njoro, Kenya.

Clement Lenachuru, M.S., 2002, Human Ecology, Egerton University, Njoro, Kenya.

Godfrey Nato, M.S., 2003, Human Ecology, Egerton University, Njoro, Kenya.

John Tangus, M.S., 2002, Human Ecology, Egerton University, Njoro, Kenya.

Waktole Tiki Uma, M.S., 2002, Human Ecology, Egerton University, Njoro, Kenya.

Non-Degree Training (Post-Doctoral Associates)

In progress

Solomon Desta, Post-doctoral associate, 1999-present, Pastoral Development, Utah State University.

Getachew Gebru, Post-doctoral associate, 2000- present, Animal Production Systems, Utah State University.

Non-Degree Training (Workshops, Short Courses, Field Tours)

Outreach (funded by the USAID Mission to Ethiopia)

Third Cross-Border Collaboration, Activity Harmonization, and Information Sharing Workshop for Ethiopia and Kenya. Held December 16-17, 2002, at the SORDU Conference Hall, Yabelo, Ethiopia. The meeting was co-sponsored by PARIMA Outreach and CIFA (Community Initiatives Facilitation and Assistance) of Kenya. The purpose of the meeting was to continue a dialogue started two years ago regarding building of more harmonious relationships across the Ethio-Kenya border. Specific foci included livestock marketing issues, peace building, reciprocal use of natural resources, and livestock health. Outcomes are documented in a proceedings volume (see publications). Over 90 people attended, with about 17 from Kenya and the rest from Ethiopia. Attendees included pastoral leaders, development agents, border administrators, and policy makers.

Second Cross-Border Pastoral Women's Tour. Held December 18, 2002 through January 4, 2003. Five dynamic leaders of pastoral women's groups in northern Kenya were taken across the Borana Plateau to 13 locations in the woredas of Yabelo, Liben, Hageremariam, and Moyale with the goal of engaging Ethiopian pastoralists in terms of mentoring on women's group formation, micro-enterprise development, and non-formal educational activities, and thereby inspiring Ethiopian women (in particular) towards further achievement. Over 630 Ethiopians (about 80% female) attended these gatherings.

Fourth Steering Committee Meeting for the Ethio-Kenya Cross-Border Initiative. Held February 26-27, 2003, in Moyale, Kenya. Twenty-six leaders of the cross-border initiative (17 from Kenya and 9 from Ethiopia) met to plan activities for the coming year. This includes efforts to obtain legal recognition for the cross-border initiative from Kenyan and Ethiopian authorities.

Training Pastoralists in Management of Local Savings & Credit Associations. Performed continuously throughout the fiscal year. Total participants equaled 791 (77% female) in six locations across southern Ethiopia. Members of associations are receiving training in the management of small-scale savings and credit associations.

First Pastoral Producers Tour to Livestock Processing and Marketing Facilities in the Ethiopian Highlands. Eight leaders of three risk management pilot projects in Dida Hara and Moyale, Ethiopia, were selected to go on a three-day tour of livestock processing and marketing facilities in the Ethiopian highlands during January 15-20. Sites visited included slaughter-houses at Modjo and Debre Zeit (ELFORA/MIDROC), the Shoa Tannery, and the Livestock Marketing Authority (LMA) in Addis Ababa. Tour members learned about quality and size requirements for animal processing and exports. One purpose for the tour was to expose producers to aspects of the livestock marketing chain and enable them to make contact with industry representatives.

Local Exchange Visits for Pastoralists to Pilot Projects. Twenty-two leaders of five risk management pilot projects (16 females and six males), along with six development agents, were taken on day-long tours to review risk management pilot projects in neighboring communities in Negele, Dida Hara, Finchewa, and Moyale during the second quarter of the fiscal year.

Second Pastoral Producers Tour to Livestock Processing and Marketing Facilities in the Ethiopian Highlands. Twenty-seven leaders of risk management pilot projects from the Guji and Borana zones traveled to Mojo and Debre Zeit to view livestock export facilities and conduct meetings with representatives of the Ethiopian Livestock Exporters Association (ELEA), Livestock Marketing Authority (LMA), Oromia Pastoral Development Commission (OPDC), Action for Development (AFD), and PARIMA. This tour occurred during September 4-7, 2003. Total attendance at the meetings was 53.

First Livestock Traders Tour to the Southern Ethiopian Rangelands. Involved leaders of trade corporations and animal industry from the private and public sectors (i.e., LMA, MIDROC/ELFORA, LUNA, Modjo Exporters, EMPIX, and representatives of Middle East trade units). They undertook a tour of range livestock production areas and met with pastoral communities in southern Ethiopia in a follow-up of previous meetings. This tour occurred during September 14-18, 2003. The total number of participants was over 50.

Research/Policy

Research Planning Meeting to Establish Collaboration Priorities for the Kenya Agricultural Research Institute (KARI) in Northern Kenya. Held May 6-9, 2003 at the National Arid Land Research Center (NALRC) of KARI at Marsabit, Kenya. The purpose of the meeting was for the PARIMA team to become more familiar with the KARI-Marsabit Station (e.g., National Arid Lands Research Center) in terms of research emphasis and needs for capacity building. About 15 people attended the meeting, with three from PARIMA and 12 from KARI.

Research Planning Meeting to Establish Collaboration Priorities for the Oromia Agricultural Research Institute (OARI) in Southern Ethiopia. Held on June 15, 2003 at OARI Headquarters in Addis Ababa, Ethiopia. The purpose of the meeting was for the PARIMA team to become more familiar with the new OARI-Yabelo pastoral research center in terms of research emphasis and needs for capacity building. About 15 people attended the meeting, with two from PARIMA and 13 from OARI.

Research Planning Meeting to Establish a Provisional Work Plan for Collaboration Involving OARI, KARI, FESNARE/Egerton, and PARIMA 2003-6. Held on July 12-13, 2003 at the National Arid Land Research Center (NALRC) of KARI at Marsabit, Kenya. The purpose of the meeting was for OARI, KARI, FESNARE/Egerton, and PARIMA to draft priorities for a three-year collaborative work plan. About 25 people attended the meeting, with Drs. Getachew Gebru and Solomon Desta and Prof. Aboud from PARIMA/Egerton, five from OARI and the balance from KARI. The meeting was followed by a brief visit to Egerton University at Njoro.

Kenyan Pastoralists and the Policy Environment: Linking Research with Decision Making. Held August 8 at the Headquarters of the Kenya Agricultural Research Institute (KARI), Nairobi, Kenya. The purpose of the meeting was to establish a dialogue between the PARIMA team and

decision-makers who affect pastoral areas in Kenya. Invitees included representatives of relevant Ministries, District County Councils, District Commissioners, Members of Parliament, representatives of NGOs, and legal scholars. The morning session consisted of several invited papers, while the afternoon session consisted of a discussion with respect to the "way forward." Over 30 people attended with media coverage provided.

Ethiopian Pastoralists and the Policy Environment: Linking Research with Decision Making. Held August 15 at the International Livestock Research Institute (ILRI), Addis Ababa, Ethiopia. The purpose of the meeting was to establish a dialogue between the PARIMA team and decision-makers who affect pastoral areas in Ethiopia. Invitees included representatives of relevant federal and Oromia state Ministries, Members of Parliament, and representatives of NGOs. The morning session consisted of several invited papers, while the afternoon session consisted of a discussion with respect to the "way forward." Over 40 people attended with media coverage provided.

PARIMA Research Meeting: Synthesis of Results from the Quarterly Repeated Survey. Held 18-19 September 2003 at Syracuse University, Syracuse, N.Y. The purpose of the meeting was to review results from the quarterly repeated survey undertaken by PARIMA from 2000-2002 and begin a process of synthesis and write-up. Five PARIMA researchers attended this meeting.

Collaborating Personnel

United States of America

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

Layne Coppock, Associate Professor, Department of Environment and Society, Utah State University, Logan, Utah.

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

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

John McPeak, Assistant Professor, Department of Public Administration, Maxwell School, Syracuse University, Syracuse, New York.

Ethiopia

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

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

Darlene Cutshall, STI Coordinator, USAID Mission to Ethiopia.

Alemayehu Reda, Assistant STI Coordinator, USAID Mission to Ethiopia.

Dadhi Amosha, Technical Expert and PARIMA Liaison, Oromia Pastoral Development Commission (OPDC).

Fisseha Meketa, Senior Expert, Save the Children (SCF/USA).

Sora Adi, Senior Expert, Borana Lowlands Pastoral Development Project (BLPDP/GTZ).

Aliye Hussen, Director General, Oromia Agricultural Research Institute (OARI).

Feleketch Lemecha, Senior Staff Member, Oromia Agricultural Research Institute.

Kenya

Abdillahi Aboud, Professor, Department of Natural Resources and Faculty of Environmental Studies and Natural Resources (FESNARE), Egerton University.

Frank Lusenaka, Lecturer, Department of Natural Resources, Egerton University.
Jean Ndikumana, Team Leader, Crisis Mitigation Office (CMO), International Livestock Research Institute (ILRI).
Patti Kristjanson, Research Scientist, International Livestock Research Institute.
Michael Ochieng Odhiambo, Executive Director, RECONCILE, Nakuru.
Chachu Tadecha, Director, Community Initiatives Facilitation and Assistance.
Mollu Dika, Staff Member, Arid Lands Resource Management Project (ALRMP).
Miriam Cherogony, Staff Member, K-REP Development Agency.
Allyce Kureiya, Staff Member, SNV-Isiolo.
Boru Halake, Staff Member, Arid Lands Resource Management Project (ALRMP).
Godana Doyo, Staff Member, Arid Lands Resource Management Project (ALRMP).
William Shivoga, Senior Lecturer, Department of Environmental Sciences and Faculty of Environmental Studies and Natural Resources, Egerton University.
Daniel K. Too, Senior Lecturer and Chair, Department of Natural Resources, Egerton University.

Collaborating Institutions

United States of America

Utah State University
Department of Environment and Society
Logan, UT 84322-5230
Phone: 435-797-3270
Fax: 435-797-4048.

University of Kentucky
Department of Anthropology
Lexington, KY 40506-0024
Phone: 859-257- 6923
Fax: 859-323-1959

Cornell University
Dept. of Applied Economics and Management
Ithaca, N.Y. 14853-7801
Phone: 607-255-4489
Fax: 607-255-9984

Syracuse University.
Department of Public Administration
Maxwell School
Syracuse, N.Y. 13244
Phone: 315-443-6146
Fax 315-443-9721

Kenya

Egerton University
Faculty of Environmental Studies and Natural Resources
P.O. Box 536
Njoro, Kenya
Phone: 254-37-62038
Fax: 254-37-61213

Crisis Mitigation Office
International Livestock Research Institute
P.O. Box 30709
Nairobi, Kenya
Phone: 254-2-630-743
Fax: 254-2-631-481

Community Initiatives Facilitation and Assistance
P.O. Box 324
Marsabit, Kenya

Arid Lands Resource Management Project
P.O. Box 53547
Nairobi, Kenya
Phone: 254-2-227-496
Fax: 254-2-227-982

Kenya Agricultural Research Institute
P.O.Box 57811
Nairobi, Kenya
Phone: 254-2-583-301
Fax: 254-2-583-344

Department of Livestock Production
Ministry of Agriculture and Rural Development
P.O. Box 30028
Nairobi, Kenya
Phone: 254-2-721-005
Fax: 254-2-721-983

Ethiopia

Livestock Policy Analysis Program
International Livestock Research Institute
P.O. Box 5689
Addis Ababa, Ethiopia
Phone: 251-1-463-495
Fax: 251-1-461-252

United States Agency for International Development Mission to Ethiopia
P.O. Box 1014
Addis Ababa, Ethiopia
Phone: 251-1-510-088
Fax: 251-1-510-043

Oromia Agricultural Development Bureau
P.O. Box 8770
Addis Ababa, Ethiopia
Phone: 251-1-155-303
Fax: 251-1-515-905

Oromia Cooperative Promotion Bureau
P.O.Box 8648
Addis Ababa, Ethiopia
Phone: 251-1-158-737
Fax: 251-1-515-905

Oromia Pastoral Development Commission
P.O. Box 8770
Addis Ababa, Ethiopia
Phone: 251-1-155-303
Fax: 251-1-515-905

Oromia Agricultural Research Institute
P.O. Box 16695
Addis Ababa, Ethiopia

Ethiopian Agricultural Research Organization
P.O. Box 2003
Addis Ababa, Ethiopia
Phone: 251-1-612-633
Fax: 251-1-611-222

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

Volunteers in Overseas Cooperative Action
P.O. Box 548
Code 1110
Addis Ababa, Ethiopia
Phone: 251-1-510-508
Fax: 251-1-531-530

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Principal Investigators

Lead Principal Investigator. D. Layne Coppock, Department of Environment and Society, Utah State University, Logan, UT 84322-5215. Phone: 435-797-1262; Fax: 435-797-4048; Email: LCoppock@cc.usu.edu.

Regional Principal Investigator. Abdillahi Aboud, Department of Natural Resources, Egerton University, Njoro, Kenya. Phone: 254-37-62038; Fax: 254-37-61213.

Principal Investigator. Peter D. Little, Department of Anthropology, University of Kentucky, Lexington, KY 40506-0024. Phone: 859-257-6923; Fax: 859-323-1959; Email: pdLitt1@pop.uky.edu.

Principal Investigator. Christopher B. Barrett, Department of Applied Economics and Management, Cornell University, Ithaca, NY 14853-7801. Phone: 607-255-4489; Fax: 607-255-9984; Email: cbb2@ cornell.edu.

Principal Investigator. John G. McPeak, Department of Public Administration, Maxwell School, Syracuse University, Syracuse, NY 13244. Phone: 315-443-6146; Fax: 315-443-9721; Email: jomcpeak@maxwell.syr.edu.

Sustainable Management of Watersheds: The River Njoro, Kenya

Narrative Summary

This report covers the first year of a multidisciplinary research effort focusing on biophysical and human-related factors governing watershed processes for the purpose of improving long-term sustainability of rural watersheds in Kenya and East Africa. The research area is a critical watershed in the Rift Valley of Kenya that has undergone recent and rapid land use change and population growth with associated negative impacts to water resources, human health, rural livelihoods, and the local economy. The core research focus is on the upland portion of the watershed where livestock and smallholder agriculture are significant components affecting the economic and ecologic health of the watershed system. A multidisciplinary team composed of faculty and partners from U.S. and Kenyan institutions have assembled data regarding the River Njoro watershed. Consultations are ongoing with various stakeholders in the watershed on matters such as water quantity and water quality. The first phase of the project covers a preliminary assessment that will serve as the basis for future research. During the past year, significant improvements have been made in capacity building for the research team members and stakeholders. The focus of the previous year's efforts was on secondary and primary data collection and analysis, participatory rural appraisal, watershed analysis, geographic information system and remote sensing, and the initiation of exchange visits among watershed stakeholders. Interventions and outreach will be developed through the integration of scientific research findings with stakeholder analyses to support local communities and decision-makers in effectively identifying and implementing local solutions to enhance the successful implementation of land management practices for the improvement of environmental condition and people's livelihoods.

Research

A summary of the advances achieved over the previous year is as follows. Significant investments have been made to build team cohesion, physical capacity, and a financial and administrative management structure for the project, achieving a solid foundation for the full project and the establishment of a center of excellence in watershed research at Egerton University. The project has generated interest in the watershed among diverse water actors in Kenya. Senior SUMAWA project researchers have already been solicited for input on various local, regional, and national water management issues at meetings and other decision-making forums. Significant gains have been made in understanding the dynamics governing watershed response within both the biophysical and human-related component of the project. Abundant secondary data has been collected from various governmental organizations, universities, and non-governmental organizations. A program for the collection of primary data (field, remote sensing, modeling) has been initiated. An

initial assessment has been made of livestock trends, practices, and watering sites in the watershed as well as of agricultural farming practices and biophysical conditions in high risk areas recently settled in the upper watershed. Multiple presentations have been delivered with several abstracts, papers, and posters submitted to national and international conferences. The training component of this project is large: to date, 14 students (11 Kenyans, 3 U.S.) have been brought into the project for their graduate training and research. Findings related to specific tasks are discussed in the following section.

Activity One: Watershed Characterization

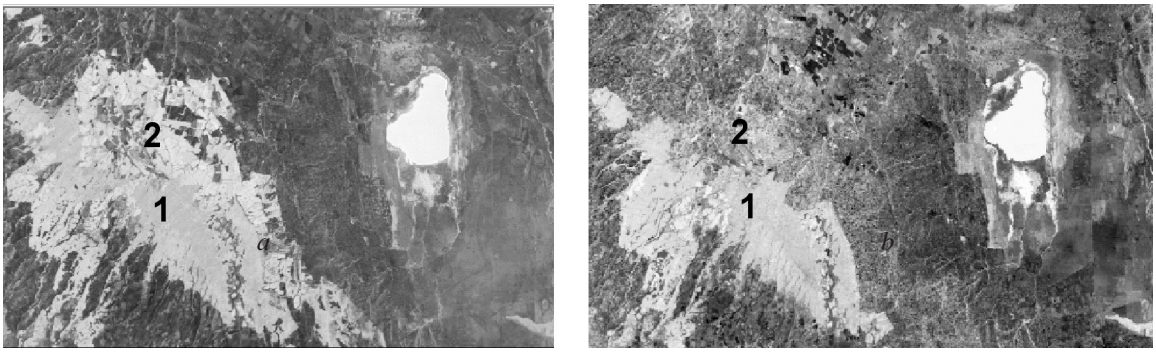
The primary focus of this activity was to collect the necessary secondary and primary data to fully characterize the watershed and establish a baseline for ongoing research efforts.

A geographic information system (GIS) database was designed and implemented that describes and characterizes the physical and social characteristics of the River Njoro watershed. The majority of site locations for biophysical and human research have been located using a global positioning system and are being converted into GIS format. GIS data layers for over 20 spatial characteristics have been either created or imported from existing sources. Important data layers include digital terrain, soils, vegetation, land management, political boundaries, roads, climate, location of precipitation and runoff gauging stations, and community locations. Several images from Landsat platforms have been imported into the Njoro GIS database. These images have been collected on a decadal scale in coordination with the collection of Kenyan national census data (1978, 1989, 1999, 2002). Preliminary watershed characterization has been completed through the integration of field research and GIS. The geospatial characteristics of the watershed, including soils, geology, vegetation, land cover, land use, and other relevant data, have been used to create an atlas of the watershed. This atlas is suitable for use in landscape assessment, identification of problem areas, stakeholder involvement and education, and in the development of statistical and physically-based models. Large- and small-scale maps describing the watershed have been created. These maps are in both digital and hard-copy format and are suitable for use by scientific investigators or as outreach tools for stakeholder education or involvement.

Our problem model relates the explosive growth in population, coupled with the changes in Kenyan governmental policy relating to de-gazetting National Forests in the early 1990s, to significant deleterious effects on the environment, human health, and economic security. The downstream effects associated with land cover change, specifically deforestation, are to be evaluated using fieldwork and hydrologic modeling tools. Remote sensing and image classification techniques were applied in the previous year to determine the extent and intensity of deforestation. Calculations of the precise amounts of loss are ongoing, but preliminary findings clearly show that large tracts of indigenous and plantation forests have been cleared for small-scale agriculture (Figure 1).

Sampling locations for water quantity, water quality, and rainfall have been identified and in most cases established as permanent monitoring stations. The watershed hydrology and ecology team implemented a suite of sampling regimes throughout the upper part of the watershed and in Lake Nakuru. Two historical but abandoned runoff measurement stations were located and revitalized, and data was collected throughout the spring and

Figure 1 - Classified Landsat imagery for 1986 (a) and 2002 (b). The images are classified such that forests show up as bright sections of the image. The numbered locations on the map show the location of indigenous forest (1) and the conversion of forested areas to small-scale agriculture (2).



summer. The Ecology team has instituted sampling protocols for aquatic investigations in the Lake Nakuru National Park (water quality and sediment sampling), along the River Njoro, and for terrestrial ecology investigations.

The sample locations identified above were visited numerous times for the purposes of water quality and quantity characterization. Water quality and quantity were measured on a continuous basis during the dry season (January-March, 2003) and the wet season (April-September, 2003). A large amount of hydrologic runoff data were collected, including twice-daily stream discharge measurements at two gauging stations in the upper-portion of the watershed throughout the sampling periods.

Secondary data for watershed and ecology components were collected from a variety of institutions and published reports in order to establish baseline and trends related to watershed and ecological health. Historical and baseline tabular data were collected for the following:

- Demographic trends in the catchment, 1989-2001.
- Lake Nakuru levels, 1956-2000.
- Lake Nakuru physicochemical parameters (lake water temperature, transparency, dissolved oxygen (DO), pH, conductivity, and orthophosphates), 1994-1998.
- Heavy metal concentrations in sediments of Lake Nakuru, River Njoro mouth, storm water, 1994-1995.
- River Njoro water quality parameters/ physical-chemical habitat characteristics: flow, water temperature, color, total suspended solids (TSS), turbidity, total dissolved solids (TDS), DO, pH, conductivity, salinity, NO_2, NO_3, NH_3, total nitrogen (Tot-N), KN, PO_4, total phosphorous (Tot-P), biochemical oxygen demand (BOD), chemical oxygen demand (COD), heavy metal concentrations, 2000-2002.
- Lake Nakuru Plankton productivity and composition, 2003.
- River Njoro/Lake Nakuru water and sediment quality, 2001-2002.
- Sewage Effluent Quality Data-Town Sewage Treatment Works, 1996-2001.
- Water bird trends, 1990–2003; plus threatened bird species and breeding sites.
- Wildlife trends (numbers and biomass), 1986 – 2000.
- Relative humidity (%) and air temperature from the Kenya Agricultural Research Institute (KARI) Plant Breeding Station, Njoro, 1972-1999.
- Lake Nakuru visitor statistics.

Water-related diseases appear to be widespread in the watershed, and have emerged as a priority problem in all three communities located in the lower and middle portions of the watershed where participatory rural appraisal (PRA) problem analysis discussions have been completed (Barut, and Rumwe and Mwigito sections of Njoro Town). Water-related diseases are ranked second out of four priority problems in Barut, eighth out of ten in Rumwe, and third out of ten in Mwigito. PRA activities in Kaptembwa, Ngata, and Nessuit are incomplete or have not yet started. One underlying cause of the high rates of water-related diseases in the watershed is very poor access to safe water supplies, resulting in consumption of fecally contaminated drinking water and insufficient quantities for basic personal and domestic hygiene. Water supply infrastructure for domestic use is far from adequate in many communities in the watershed where significant sections of the population, mostly the poorest, collect and transport water by hand from the river or from communal boreholes where water charges are relatively high. Evidence from Egerton University indicates that groundwater, the main developed source of domestic water supply in the watershed, may also be contaminated by fecal matter, and if untreated, poses a health risk. Health problems identified in the PRA exercises so far include:

- Typhoid (Barut, Mwigito)
- Diarrhea (Barut, Mwigito)
- Amoebas (Rumwe)
- Eye infections (Rumwe)
- HIV/AIDS (Barut)
- Malaria (Barut, Rumwe, Mwigito)
- Pneumonia and flu (Barut, Rumwe, Mwigito)

Research at Egerton University is underway to identify the patterns of water-related diseases in the watershed, with particular focus on typhoid and diarrhea diseases. Registered cases of typhoid, bacillary dysentery, amoebiasis, and diarrhea diseases over the last five years are being collected and analyzed by Egerton University M.S. student Joseph Kiragu at three locations in the watershed: Nessuit Dispensary (upper zone), Njoro Health Center (middle zone), and Barut Dispensary (lower zone). Disease patterns by age, sex, season, and residency will be analyzed, and the underlying causes evaluated in a thesis prepared for December 2003. Data to analyze the private and public costs of this disease burden in the watershed will also be assembled as part of this research. These results will provide a foundation for subsequent scientific investigations into drinking water quality, water supply, and sanitation and hygiene conditions in the watershed (see Activity Four) and stakeholder discussions on the causes and solutions for improving environmental health conditions at sub-group, community, and watershed scales. Findings will be introduced at stakeholder and community meetings for discussion and evaluation of actions that affect the domestic water supply conditions and community health in the watershed.

Activity Two: Socio-Economic Assessment

Tasks associated with the socio-economic assessment were designed to collect baseline and historical data. These data are used in economic modeling and analysis as well as in the development of intensive household questionnaires and community outreach.

An M.S. student has started collecting case statistics on typhoid and diarrhea diseases treated at clinics and hospitals in the watershed over the last five years to analyze water and sanitation-related disease patterns.

Modifications were made this summer to improve the research proposal and data collection protocol for this M.S. research project. The work should be completed by the end of 2003.

Livestock assessment has been initiated at the household and watershed scale. The determination that intensive and extensive grazing has been occurring at the watershed headwaters is a significant link between grazing pressures, economic utilization, and watershed health.

Copies have been obtained of archival documents and reports from the Njoro Division Agricultural Office that contain useful information on market prices for goods and inputs, livestock diseases, grazing practices, and extension activities.

Fieldwork was conducted this summer to assess agronomic and forestry practices of small farmers recently settled in the upper reaches of the watershed. The goals of this research are to understand how poor rural producers in this keystone position in the watershed relate to larger issues of natural resource management, local ecology, and subsistence strategies, as well as to evaluate opportunities to adapt and develop indigenous resource management strategies, focusing in particular on the use and integration of agroforestry species to improve soil and resource conservation. The research will develop an in-depth understanding of potentially viable production methods, technologies, constraints, and farmer willingness to participate in promising changes and will make recommendations for extension actions and methods to improve agricultural production and farmer livelihoods while simultaneously improving watershed health and resource conservation among this group of producers in the watershed. Included will be a recommended list of appropriate species and agroforestry technologies adapted from farmer conditions and practices in the area.

The study includes 15 small farm households, nearly all having settled in the watershed within the last ten years, with many only three to five years ago. All are located above Nessuit center, between 2,747 and 2,378 meters elevation, on sloped lands in close proximity (<200 m) to first-order streams and springs. Six are headed by females. Farms range in size from two to ten acres, with an average of 5.4 acres. Eight out of the 15 households own cattle, ranging from one to 15 head. Sheep and goats are less common. Only two households have no livestock at all, while four have only chickens. Out of the 15, nine are using chemical fertilizers, and three of these also apply chemical pesticides. Reported application rates for fertilizers vary from about ten to 50 kg./acre.

A variety of types of data and methods are being used in this study, including in-depth interviews, soil analyses, biophysical assessments, agro-economic inputs, yields and income data, perceptions of environmental and resource conditions, inventory of tree species, uses, and forestry and conservation management practices for each of the 15 farm households. These data are being augmented with outside informant interviews, archival research, botanical and ethno-botanical information, geographic analyses and soil erosion risk assessments for each location, economic assessment of production systems, and research literature. The final report in the form of a thesis is expected by September 2004.

Key issues emerging from the study so far indicate varied land tenure status (most have no formal title, some renting) and ethnic divisions and tensions among the three resident groups (Ogiek, Kipsigis, and Tugen) in relation to land access. Differences in knowledge of

resource management strategies, farming experience, and agronomic traditions also widely affect practices and perceptions. For example, Ogieks are traditional hunter-gatherers with extensive knowledge of indigenous tree species and uses, while Kipsigis and Tugen have brought their former agro-pastoral practices with them.

Access to markets is a major constraint on agricultural income and production in this part of the watershed where the road network is very poor or nonexistent. Because yields and farm income are often inadequate, many residents in this part of the watershed try to diversify their income with wood-related products (fuelwood, charcoal, and timber) extracted from the already threatened upland forests, further exacerbating the rapid rate of deforestation underway since the early 1990s. Wood product shortages within the watershed and in Nakuru Town fuel strong demand for these products. The study highlights a major problem for resource management: without alternative sources and with insufficient income from farming, poor rural families often have no choice but to turn to the remaining natural resource base (trees, in this case) to survive.

At each household survey location, soil samples were collected to measure the soil's physical and nutrient qualities. Global positioning systems (GPS) locations will be used to extract topographic and geographic data from available geographic information system (GIS) layers in the analysis phase. Two visits to the International Center for Research in Agroforestry (ICRAF) were made to collect information on agroforestry best management practices. This information will be analyzed and combined to evaluate and propose environmentally sustainable agroforestry practices and improved farming methods that would be appropriate for the biophysical and economic conditions typical of these upper watershed farmers.

The design of the baseline household survey is ongoing, with comments solicited from the other research components and the U.S. Co-PI. A half-day meeting to clarify the goal, objectives, methods, sampling strategy, organizational steps, and tasks for the design and execution of the baseline survey was held during the summer with the U.S. Co-PI. A quantitative economist with survey experience has been identified to help in the design and execution of the survey, and plans are being formulated to recruit a survey team and begin surveying households in the fall.

Activity Three: Stakeholder Involvement

This research project relies heavily on the interaction of physical and social scientists. Our intended goal is to fully embed findings from stakeholder involvement into the development and implementation of biophysical research, and for the research findings to be available to interested stakeholders throughout the term of the project. Towards meeting that goal, members of the stakeholder involvement team initiated participatory meetings at the household and community level at sites throughout the upper portions of the watershed.

Stakeholder workshops (barazas) and interactions in six target communities and a two-day watershed-wide stakeholder workshop were successfully held between December 2002 and April 2003. The project was introduced to stakeholders throughout the upper portion of the watershed. Project goals and issues were discussed, and perspectives on the use of the watershed were shared. Basic information on the communities, stakeholders, and institutions involved in the River Njoro watershed was gathered.

The communities along the Njoro River are composed of sub-groups with diverse livelihood interests and activities dependent on the natural resource base, in particular to water and riparian resources in the public domain in the watershed. The first stage of the stakeholder PRA activities have focused on identifying and understanding these different sub-groups in relation to surface water and river bank conditions in the riparian corridor. Table 1a summarizes some initial results from the participatory assessments in four of the six communities. It shows the involvement of different sub-groups in resource use and decision-making. The findings indicate that women have key responsibility and decision-making roles for domestic water supply from the river and firewood collection along the banks, men for livestock watering and grazing decisions (esp. large livestock such as cattle) and small-scale irrigation, and young men for water extraction, fodder collection, and other resource extraction activities for cash sales or hired work. Men and women both are involved in timber/wood gathering for house building, and in maize cultivation decisions, while men alone are involved in wheat cultivation. Direct

Table 1a - Resource extraction and uses by communities along the Njoro River.

Community	Group	Surface Water Extractions from River							River Bed/Bank Materials			Riparian Trees/Vegetation/Cultivation								
		D	L-L	L-S	SL	IR	BL	C	SD	RK	HS	FW	FDC	FDG	VG	VG-MZ	VG-WT	BM	HB	HY
Barut	Women	*d	*			*	*d		*d			*d			*d			*	*	
Ngata	Women	*?	*	*d											*d	*d			*d	
Rumwe	Women	*d				*d	*d					*d		*					*d	
Mwigito	Women	*d	*d			*				*d		*d								
Barut	Men	*	*d			*?	*d		*d									*d	*d	*d
Ngata	Men	*	*d		*?											*d	*d		*d	*d
Rumwe	Men		*d			*d	*d		*d	*d				*d					*d	
Mwigito	Men	d	*d			*d				*d		*d		*d						
Barut	Youth	*	*		*d	*												*d	*d	
Ngata	Youth	*		*d	*?															
Rumwe	YgMen	*d	*		*d								*d	*						
Mwigito	YgMen[d]																			
Barut	Others[a]		*		*d		*d	*d	*d			*d							*d	
Ngata	Others[a]																			
Rumwe	Others[b]		*d		*d		*d		*d	*d	*d	*d	*d	*d					*d	
Mwigito	Others[c]	*d	*d		*d	*d				*d		*d		*d						

Source: Initial PRA Reports (2002-2003)
Resource extraction and use codes are on the next page.

Notes:

*: use activity carried out by group
d: decisions regarding use made by group
?: likely decision-maker, but unclear from initial report
[a] "Others" refers to people from outside the community and ministers (in case of baptism)
[b] "Others" refers to hired hands and people from other sections of Njoro Town (L-L); other communities in the watershed such as Ngata and Nessuit, as well as outside the watershed (e.g., Lare, Ngecha, elsewhere) (L-L and FDG); traders and construction people from outside the community and watershed (BH, RK); County Council (SN, RK); KARI, forest department, and the Forest Action Network (HS)
[c] "Others" also includes male youth which were not split out in the Mwigito PRA, and people from other communities in the watershed (L-L)
[d] Included in "O" for Mwigito

Table 1b - Resource extractions and uses by institutions, industries, commercial, and other actors along the Njoro River.

Community	Actor	Surface Water Extractions from River							River Bed/ Bank Materials			Riparian Trees/Vegetation/Cultivation									GW	WW
		D	L-L	L-S	SL	IR	BL	C	SD	RK	HS	FW	FDC	FDG	VG	VG-MZ	VG-WT	BM	HB	HY		
Rumwe	Rumwe Society	*	*			*										*	*				*(2)	
Rumwe	Nakuru County Council	*							*	*											*(?)	
Rumwe	FAN										*											
Mwigito	Mwihoti Water Proj.																				*(1)	
Mwigito	Kiragu F. Dairy		*																		*(1)	?
Mwigito	Kiptanui F. Dairy		*																		*(1)	?
Mwigito	Njoro Canning																				*(1)	*
Mwigito	KH Flower Co.	*																			*(1)	?
Mwigito	EU	*	*			*										*	*				*(10+)	*
Mwigito	KARI	*				*					*					*	*				*(3)	?
Mwigito	Tim-Sales Enterprise																				*(1)	
Mwigito	Gikombo Farm	*																				

* : use activity carried out by group
? : likely but unclear from initial PRA report.
(#): number of active boreholes on property adjacent to river

Source: Initial PRA Reports (2002-2003)

Resource extraction and use codes in Tables 1a and 1b:

D: fetching water for domestic use
L-L: watering large livestock at the river
L-S: fetching river water for or watering small livestock at the river
S: fetching water for transport and sale
IR: river withdrawals for irrigation adjacent to river
BL: fetching water for construction and building houses
C: cultural uses, such as baptisms
SD: extracting sand from river for construction
RK: extracting rocks and gravel from river for construction
HS: humus gathering along banks for tree nurseries
FW: gathering fuelwood along banks for domestic uses, for sale, and for charcoal making
FDC: grass fodder collection for sale
FDG: grass fodder livestock grazing along river banks
VG: growing vegetables along the side of the river (e.g., potatoes)
VG-M: growing maize along the side of the river
VG-W: growing wheat along the side of the river for sale
BM: gathering wood, bark, parts of trees for house building materials
HB: gathering herbs and other plant matter for medicinal purposes (roots, barks, leaves)
HY: bee-keeping for eventual sale of honey
GW: groundwater extraction by borehole
WW: wastewater discharge to river

and separate engagement with each of the relevant sub-groups should be built into subsequent PRA activities and stakeholder dialogues when developing and discussing alternative options for improved management of riparian resources. The initial PRA activities were done in mixed groups with relatively poor representation of women and no youths. This should be rectified in future PRA activities, with better representation of women and youths, and organizing separate PRA activities with each sub-group.

The PRA information shows that the exploitation of water, riverbed materials, and vegetation in the riparian zone (medicinal herbs, firewood, and fodder) by people from outside the community is significant, especially in the middle and lower parts of the watershed (see Table 1a). Better identification of, active engagement with, and inclusion of these groups will be necessary in planning and implementing local community actions to improve conditions and conserve riparian resources. The planned tiered workshops offer an opportunity to begin engaging in dialogue to develop cooperative solutions between communities and "outsiders," in cases where outsiders are actually from other communities within the watershed (see Table 1a). Some of these outsiders are in fact institutional, public, or commercial enterprises in the watershed. Table 1b provides an initial list of institutional, commercial, and public actors and their resource extraction activities as identified in the initial PRAs.

Community problems and priorities for resource management along the Njoro River revealed in the PRA activities are listed in Table 2. Water scarcity and water quality problems for human and livestock health, related human diseases, and fuelwood scarcity are top-ranked problems in two of the three communities so far investigated. Water supply problems are less important in Rumwe, the community along the section of the Njoro River that runs through Njoro Town. This may be because it has the best domestic water supply conditions of the three communities, serviced by communal boreholes and piped house connections, although poorer segments of the local population rely on the river as their water supply source.

Future activities with stakeholders will revolve around the policies and legalities governing the management of natural resources in the watershed. As a first step in developing an intervention in this regard, relevant tools for management and assessing individual and environmental rights were located. Copies of the recently enacted Government of Kenya (GOK) Environmental Coordination and Management Act (2002) and other GOK acts and laws governing use, rights, standards, and responsibilities for management of watershed resources were obtained (The Water Act-Chapter 372 of the Laws of Kenya; The Tea (Amendment) Act, 1999; The Kenya Roads Board Act, 1999; The Environmental Management and Coordination Act, 1999). A preliminary extraction and summary of relevant sections was prepared as the basis for further discussions and dialogue with stakeholders on their practical administration, effectiveness, and implementation.

Activity Four: Capacity Building

Numerous capacity building activities were completed to enhance the physical, intellectual, and team capacity for the long- and short-term success of the project.

The management structure of the Kenyan and U.S.-led research teams was optimized, as the research team was altered and divided into four components based on individual skills and the objectives and activities of the

Table 2 - Community problems and priorities for resource management along the Njoro River.
B = Barut; R = Rumwe (Njoro); M = Mwigito (Njoro)

Problem	Perceived Causes & Issues	Ranking		
		B	R	M
Insufficient (river) water	River runs dry periodically (Barut); lack of alternative sources; poor river protection; shallow dams upstream (Barut); drought; irrigation upstream; sand scooping; overstocking of animals; outsiders extracting water for sale, too many users (Barut); obstruction of river flow (Rumwe).	1	7	
Low income	Over-reliance on milk and maize, farm employment, and sawmills employment (which have shut down); reliance on middlemen for marketing; lack of storage facilities for wheat; lack of market for produce.		1	
Water	Poor quality water, not enough- scarcity esp. in January-February dry season; water siltation.			1
Water-borne diseases (consuming polluted river water)	Run-off with dirt including human waste; dirty water from washing of vehicles, laundry, and bathing in river; dirty effluents; lack of latrines; soil erosion; sand extraction makes river dirty; dumping of waste in river (from Kaptembwa in Barut).	2		3
Poor community cooperation	Poor leadership; ignorance about group value.		2	
Fuelwood (scarcity)	Deforestation; failure to plant trees on own shambas; closing down sawmills.		4	2
Polluted river water	Human diseases; no water access points, lack of sewage system, garbage collection.		8	
Sand scooping (extraction from the river)	Related to unemployment; rising demand for sand; laxity in enforcing rules; destroys roads, makes river dirty; causes land slides, deaths, and devaluation of land.	3		
Weak community water institutions	Low income; low level of skills to start income generating project; lack of trust among members; poor leadership; poor project management.		3	
Flooding	Siltation of the river; soil erosion; sand scooping; destruction of vegetation on farms and on river banks increasing run-off to river; bank vegetation removal related to fuel wood gathering, tree felling, and tree dying from root/bark removal.	4		
Electricity	In village but not connected to houses.			4
Weak Nakuru County Council	Lack of sewage system, garbage collection.		5	
Insecurity	Unemployment; drunkenness.			5
Unemployment	No jobs.			5
Lack of riparian management plan	Lack of knowledge; lack of ownership of riparian zone.		6	
Dumping	Attitude.			6
Livestock diseases	Plastic papers; outbreaks; expensive drugs.			7
Lack of extension services (soil erosion)	Extension officers never seen; steep slopes; lack of terraces.			8
Poor roads	Erosion causes pot holes; no bridges, river Njoro blocks access to Egerton University for many residents who work there; lack of culverts.			8
Seasonality of fodder			9	
Inadequate infrastructure	No water access points, inadequate bridges, lack of storage facilities.		10	

Source: Initial PRA Reports (2002-2003)

project. Several team members were dropped from the project due to overlapping abilities, while other scientists were brought into the project when specific needs were identified. A two-day workshop for the entire research team was held in which team members were exposed to the language and objectives of each of the four research components. The budget cut resulted in the cancellation of a planned two-day training to expose the entire research team to PRA and GIS methods and objectives. Consequently, the project team has experienced some difficulty integrating and interlinking research activities and planning across components, especially due to the general lack of experience with GIS, and how it can be used to integrate data sets across scales and disciplines. Further contributing to difficulties integrating components is the lack of skills among project researchers and students in database design, manipulation, and information management, and the absence of a GIS technician to manage the GIS data sets to facilitate access to project data by researchers and students from different components.

Management and budgeting capacity was enhanced through attendance at a three-day management training seminar held in Washington, D.C. following the Global Livestock CRSP Program Conference. The facilitator was the president of Team Technologies, a consulting firm specializing in international development project management and grantsmanship. All team PIs and co-PIs attended. Special attention was given to the use of logframes in grant writing and the conceptualization of projects. The training exercises were crucial in helping the project team leaders to define a common vision of the problem model, develop the long-term goals of the research project, and construct a shared logical framework and tools with which to implement and manage the full three-year project.

To address the physical capacity needs in Kenya, equipment, computers, software, and educational needs were identified. Where possible, these needs were addressed via capacity building in order to ensure project success and to help develop Egerton University into a regional center of excellence in integrated watershed studies. Numerous capital expenditures critical to the short- and long-term success of the project were made. A summary list follows:

- Rental of a secure facility with multiple offices for research staff, project leaders, fiscal manager, and students. Computers, books, and other resources dedicated to the SUMAWA project are maintained in this office suite.
- Acquisition of telephone and internet capability dedicated to the SUMAWA project.
- Delagua Portable Field Kit to test drinking water quality (fecal and total coliform counts), designed for and extensively used in developing countries, was acquired and an initial orientation provided to the Ph.D. student who will be responsible for using the equipment in her research.
- Four desktop personal computers (Egerton).
- Five laptop computers (Egerton, Moi, Fisheries, Wyoming, Davis).
- Two GPS receivers.
- External hardware for computers: scanner, printer (3), multi-function machines (2).
- Two digital cameras.
- Various hydrologic, soil, and ecological sampling equipment.
- Establishment of a project library with over 20 recent books and 200 journal articles.

- Specialized software for project investigations, including initial training orientation: Epi Info 2002, the World Health Organization/Center for Disease Control epidemiological and disease surveillance statistical software package; SYSTAT, a complete statistical software package; ArcView3.2 and ArcGIS, GIS software packages; and Imagine, a remote sensing software package.

Activity Five: Submittal of Long-Term Research Proposal to GL-CRSP and Extension of Research

In this phase of the project, a full proposal for submittal to the GL-CRSP was developed. This proposal is intended to build on the capacity building and preliminary data analysis performed during the current research phase. This proposal is a multi-year (3-5 years) intensive applied research program integrating watershed assessment using cutting-edge research and stakeholder involvement.

A core function of this research group was to develop a scientifically defensible approach to integrated watershed assessment. The submitted proposal was funded by the GL-CRSP for a three-year period. The research within the proposal will build on the capacity building and preliminary data analysis performed during last year's research phase and is a multi-year (3-5 years) and intensive (integrated watershed assessment using cutting-edge research and stakeholder involvement) research program aimed at both understanding the system dynamics governing a complex and evolving watershed and improving people's livelihoods within the watershed.

Several key members of the research team traveled to Washington, D.C. to participate in the GL-CRSP Program Conference. A poster presentation was prepared that details the problem statement, project objectives, scope of work accomplished to date, and proposed research. Each research component team contributed material to the poster. In addition, the Lead PI (S. Miller) gave a presentation on the SUMAWA project, including both long-term project goals and intermediate findings.

Gender

Women in the River Njoro Watershed are centrally responsible for domestic water supplies, family health and hygiene, firewood collection, and they carry out important roles in both farm and non-farm household income production activities that have implications for the sustainability of watershed resources. Furthermore, a larger portion of poorer households in rural and urban areas tends to be headed by women. For this reason, gender analysis is included in the participatory rural appraisal methods being used during the assessment phase with communities in laying the foundation for stakeholder involvement in managing the watershed. PRA exercises identify the roles, responsibilities, and activities of women relative to men, youth, and other actors in the analysis of different benefits provided by local watershed resources community members. This information will allow for organizing subsequent phases of project outreach and dialogue using separate strategies for men, women, and youth, as needed for the resources issues in question. The inclusion of female representatives in the planned exposure visits, tiered workshops, and stakeholder trainings will also be key to ensuring that diverse stakeholder interests, perspectives, and impacts, particularly for poor households, are represented in developing interventions and management plans for the watershed.

Policy

One of the primary research thrusts in this project is stakeholder involvement and outreach. Through the participatory rural appraisal mechanism, we have started to assess the feasibility of possible interventions. The problems inherent to the River Njoro watershed were initiated at the highest levels of government in the form of political favor for support. Thus, the question of public policy involvement is central to understanding the mechanisms controlling land tenure, management, and stewardship. For example, preliminary results indicate that in Nessuit, which includes the most recently settled upper portion of the watershed, sub-communities are based on a mixture of historical and recent settlement patterns, and tribal and land tenure differences. In the much older Ngata area of the watershed, the two sub-communities are geographically divided by the River Njoro, and little to no cross-communication occurs between these sub-communities. Understanding the different local and regional issues is essential to establishing successful linkages among science, policy, and land management since decision-making must account for realities on the ground.

In the long-term (after this year), activities with stakeholders will revolve around the policies and legalities governing the watershed. The Kenyan government has recently issued a series of environmental rulings and legislation which change the historic paradigms of natural resource management. Members of the research team will be responsible for assessing the usefulness and applicability of these laws within the context of the watershed and the potential for empowering local communities and stakeholders for greater control over basin resources. An informational program will be developed that exposes local landowners and managers to these tools for taking control of their local land management. Copies of the recently enacted GOK Environmental Management Act (2002) and other GOK acts and laws governing use, community rights and responsibilities for management of watershed resources have been obtained, which will form the basis for further analysis, discussions, and dialogue with stakeholders on their practical implications and implementation.

Central to the successful implementation of interventions has been the identification of key stakeholders and policymakers that are in positions of authority (whether that be moral, ethical, or managerial) and ensuring that they are committed to the success of the proposed intervention. We have initiated a series of tiered workshops that are taking place longitudinally within the communities of the watershed. Community leaders and policymakers are included in these workshops, the aim of which is to facilitate the transfer of knowledge from the research (biophysical, socio-economic) realm into the applied realm.

Outreach through personal communication and networking is ongoing in Kenya, and the Host Country PI and Co-PIs serve as science ambassadors to land managers, politicians, and policy makers. Long-term efforts are aimed at establishing professional relationships with policymakers beyond those in the watershed, including at the national or international level, NGOs, and the Ministry of Water. Invitations to ministry officials will be extended for regional seminars and conferences, such as the proposed May seminar series and the June WEAP training. It is proposed that research briefs prepared for the GL-CRSP be made available to government ministries.

Outreach

Outreach and stakeholder involvement are the lynchpins of this research effort. There is an equal commitment to biophysical research and the transfer of knowledge and technology back and forth between research and social scientists. One of the benefits of having faculty from Egerton University central to the project is that the university itself is a stakeholder within the watershed. There is a strong commitment on behalf of the university administration and faculty to assume stewardship in order to understand and improve the overall condition of the watershed.

Outreach activities at the community level have occurred in the communities located in the upper portions of the watershed. Stakeholder workshops (barazas) and interactions in six target communities and a two-day watershed-wide stakeholder workshop were successfully held between December 2003 and April 2003. Project goals and issues were discussed, and perspectives on the use of the watershed were shared. Basic information on the communities, stakeholders, and institutions involved in the River Njoro watershed was gathered. These data are being made available to the participants and their input will be encouraged throughout the life of the project.

The primary economic driver in the upper watershed is agriculture, primarily at the smallholder (household) scale. Grazing in the upper portions of the watershed is critical to people's economic security. However, the communities along the Njoro River are composed of sub-groups with diverse livelihood interests and activities dependent on the natural resource base, in particular to water and riparian resources in the public domain in the watershed. The first stage of the stakeholder PRA activities have focused on identifying and understanding these different sub-groups in relation to surface water and river bank conditions in the riparian corridor. This approach will show the linkages among various land management activities and downstream water quality and quantity.

Local involvement and knowledge transfer is integral to several project components. Data collection efforts have been initiated at local schools. In the coming year, meteorological stations will be installed at two local schools who will participate in data collection efforts. Scientists from the research team will interact with students and teachers at these schools to explain key scientific principles and encourage an understanding of the environment and the impact of humans on their surroundings. Pond aquaculture is a promising prospect for improved and diversification economics in the watershed. A demonstration project has been initiated on the Egerton campus. Local citizens will be incorporated into the project in order to encourage the establishment of these ponds. The Kenya Fisheries Department is responsible for identifying interested parties and facilitating their involvement.

Developmental Impact

Environmental impact and relevance. Over the years, degradation of water resources in terms of quantity and quality within the River Njoro watershed has occurred due to poor watershed management. This has resulted in serious degradation of the ecological integrity and hydrologic cycle within the watershed. This is shown by loss of biodiversity, habitats, and interference with the hydrologic processes, i.e., infiltration into groundwater, run-off and interception of raindrops within the watershed. Consequently, the trend has resulted in declining socio-

economic well-being of inhabitants and their livestock, threatening Lake Nakuru and the surrounding national park, which is a major income generating resource through tourism. The long-term goal of improving watershed health will be achieved through incremental improvements and demonstrable successes within the Njoro watershed. These successes will serve as models for transferable practices to other watersheds in the region. Appropriate indicators for watershed and ecological health assessments will be determined during the coming year. These indicators will be determined from secondary, primary, and simulation data and serve as a baseline for interpretation of improvements over the next several years. Instrumentation and monitoring will supplement the interpretation of these indicators. Water resources are of critical importance to the stakeholders, and it has been observed that water quality and quantity, both in the surface and groundwater supplies, has been decreasing over the past decade due to land tenure changes. During the coming year we will plan and begin to implement interventions designed to improve the quantity and quality of water resources (agroforestry, assessment techniques for land managers, and alternative grazing and cropping systems). The stakeholder involvement group is focusing on developing good relations with stakeholders and managers within the watershed, and policymakers who have control over the manner in which the watershed is governed. These foundations of strong stakeholder interaction and outreach will support the short- and long-term success of implementation of interventions and knowledge transfer. Ongoing dialogue with land managers and policymakers will be supportive of this indicator as well. Longitudinal site visits and exposure of stakeholders to empowerment tools, such as environmental legislation and the development and implementation of watershed community action plans are intended to support the improvement of people's health and livelihoods.

Agricultural Sustainability. Given that small- and medium-scale agriculture are the primary economic forces in the watershed, it is critical that principles of sustainability be developed and implemented in the watershed. In the coming year, we will identify appropriate interventions and practices to improve farming, forestry, soil management, income opportunities, water supply conditions, and community watershed awareness and develop proposals to establish demonstration sites, behavioral trials, and other activities to test effectiveness and acceptability jointly with stakeholder and community participation. These interventions will be developed in coordination with members of the socio-economic team to ensure feasibility and practicality of implementation.

In the coming year we will test and demonstrate the feasibility of aquaculture in the watershed. One of the principal hindrances to economic development in the region is the overwhelming dependence on maize production. By introducing other mechanisms for economic and food security we intend to demonstrate the importance of diversification and alternative agricultural practices. The test site will be on the Egerton University campus. An integrated effort, this program will serve a dual scientific and outreach role: the ponds will be managed by scientists from Moi University who are interested in experimental design and maximization of pond aquaculture systems, while team members from the Department of Fisheries will manage a citizen outreach and training component that will draw upon the local population to construct, manage, and track the

economics of the pond project. This year's objective is to establish a functional and economically feasible aquaculture demonstration site that will serve as a site for technology transfer. Other demonstration sites and technology transfer schemes will be implemented in future years.

A pilot project related to strategies for on-farm water management on steep slopes will be developed. Results of the preliminary phase indicate that there is a continuous cultivation without adequate soil conservation measures on the steep slopes of the watershed. Sustainable management of the agricultural lands can be achieved through agroforestry, hedgerows, and grass strips to reduce soil loss and runoff. These simple agroforestry technologies will need to be established on the steep slopes in order to determine the soil losses. This will also assist in assessing their effectiveness and adoption as soil conservation technologies.

Evaluation of the potential for agroforestry and tree nurseries for economic and ecological benefits is an ongoing effort. Data recorded from 13 sites along the River Njoro suggest that five key indigenous tree species occur along the river. These are: *Acacia xanthophloea, Acacia abyssinica, Cussonia holstii, Podocarpus,* and *Olea africana*. The zoning of these trees along the river profile signifies altitude as the major cause of the zoning. Community tree nurseries exist in the watershed, and an assessment of their impacts and usage within the watershed will provide baseline data for the potential to implement larger-scale interventions to improve forest health.

Contributions to U.S. Agriculture. It has long been recognized that water resources and their effective use and management for long-term sustainability are crucial to agricultural stability. This statement applies with equal validity to Kenya and the U.S. The problems facing residents of the Njoro watershed are undoubtedly more critical than those in developed nations such as the U.S., but parallels exist nonetheless. For example, the watershed is comprised of a mixture of stakeholders with a variety of complementary and competing interests, including agriculture, livestock grazing, business, residents, and the environment itself. Land cover and land use are rapidly changing due to population pressures and policy decisions with resultant negative off-site impacts. This research project will provide a demonstrable method for integrating biophysical and human-focused research for sustainable watershed management in an agricultural setting. The overall purpose of the research is to develop tools and techniques that will allow local stakeholders, managers, and policymakers to obtain a clear understanding of the processes governing the system. These tools and technologies will be transferable to other systems, including the U.S.

Contributions to Host Country. In the coming year preliminary tools, such as hydrologic and ecologic models, will be developed that will describe the processes governing watershed health and the response to changes in land management and tenure. These tools will provide a scientific basis to interested parties, such as land managers, policymakers, and local residents interested in understanding their physical environment.

A series of interventions for the improvement of economic stability, ecologic health, and hydrologic resources are planned. These interventions include demonstration plots for pond aquaculture, agroforestry, alternative agricultural practices, and water distribution. It is anticipated that these interventions will have a localized beneficial impact. An outreach component will be

implemented that links local landowners to the planned interventions so as to facilitate their adoption on other regions of the watershed that would have a larger-scale impact on watershed health. A school-based outreach and education component will introduce schoolchildren to land stewardship and environmental awareness.

The Njoro watershed will be established as an experimental watershed with the addition of continuous monitoring stations for rainfall and runoff. Kenya has a sparse network of rain gauges and there is a paucity of useful runoff data. Our team has been unable to uncover any records of event-based runoff in the Rift Valley; this knowledge gap is a serious hindrance to scientific understanding of the fundamental processes that govern hydrologic response as well as water quantity and quality. These monitoring stations will provide a means to use cutting-edge tools and models for scientific assessment and land management.

There is a significant training component for Kenyan students and researchers. Nine Kenyan students will be trained during the upcoming year, many of whom will continue their careers working for ministries and policymaking organizations. The successful training of students in integrated and sustainable research and decision-making will be beneficial to Kenya.

Linkages and Networking. While this project is relatively nascent, there have been significant strides taken towards networking and developing institutional linkages. This project was conceived as a multidisciplinary effort requiring the involvement of multiple educational and institutional partners. Linkages have been established among the following Kenyan institutions: Egerton University, Moi University, Kenya Fisheries Department, and Kenya Wildlife Service. In addition to these more formal partnerships, linkages have been made with a project funded by the Rockefeller Foundation in Kenya, the Kenya Agricultural Research Institute (KARI), the Lake Naivasha Riparian Conservation Committee, and the Friends of Mau Watershed. Linkages are being developed with the USAID Mission in Nairobi, the Rockefeller Foundation, the Macaulay Institute (Aberdeen, Scotland), and the Wyoming GIS Center.

Collaboration with International Research Centers (IARCS) and other CRSPs. Strong collaborative relationships have been developed with the Pond Dynamics/ Aquaculture (PD/A) and the Soil Management (SM) CRSPs. In the year that has just concluded, significant funding and technical leadership was provided by the PD/A CRSP. The formal agreements with Moi University and the Fisheries Department were greatly enhanced by the participation of the PD/A CRSP. In the coming years, we have an agreement to interact with team members of the Trade-Offs project (funded by the Soils CRSP, Lead PI John Antle), which is utilizing a trade-off model for household and agricultural economics. This will be a collaborative effort aimed at utilizing cutting-edge tools that link biophysical and human-related inputs in watershed assessment, planning, and interpretation. Data collection efforts for agricultural economics and problem model development will be coordinated, and data regarding on- and off-site impacts associated with decision-making and economic impacts will be shared between the groups.

Other Contributions

Support For Free Markets and Broad-Based Economic Growth. One of the primary goals of enhancing watershed health

and agricultural sustainability is to foster economic stability and growth. The inability of local smallholders to transport goods and services beyond the local market was identified as a hindrance to development and growth. This barrier may best be surmounted through a policy and legal framework. However, the implementation of local and regional interventions are planned to enhance economic growth. Examples of these economic stimulants include upland grazing practices, pond aquaculture, agroforestry, and sustainable agriculture techniques (especially related to steep slopes). In addition to land management practices directly related to enhanced productivity, the project objectives of improving water quality and human health will directly improve local economics as stress is reduced within the system.

Contributions to and Compliance with Mission Objectives. The research activities directly address three strategic objectives as defined by USAID: building human capacity through education and training, protecting the world's environment for long-term sustainability, and encouraging broad-based economic growth and agricultural development. One of the four Kenyan USAID Mission objectives is to promote natural resources management, and this project directly addresses that critical need in Kenya. Spatial analysis has been widely used in support of decision support for agriculture and land management practices, and several of the team members, including the PI, have extensive experience in those areas. Long-term sustainable development in Kenya will hinge on the successful implementation of emerging scientific tools. This project will provide a mechanism to adequately prepare students and faculty to act as resource managers and utilize emerging technology in their research analyses.

Concern for Individuals. The outreach and stakeholder involvement components of this project are targeted at the community and household level. Central to the successful implementation of interventions is identifying key stakeholders and policymakers that are in positions of authority (whether that be moral, ethical, or managerial) and ensuring that they are committed to the success of the proposed intervention. We have arranged for a series of tiered workshops that will take place longitudinally within the communities of the watershed. Community leaders and policy makers will be included in these workshops, whose aim is to facilitate the transfer of knowledge from the research (biophysical, socio-economic) realm into the applied realm. The concept behind this structure is to ensure that watershed- and community-scale activities are not disconnected from the intended goal of improving the livelihoods of individuals.

Support for Democracy. One of the principles of good governance and successful democratization is the establishment of functioning policies and legalities related to people's livelihoods and environment. As a first step in developing an intervention in this regard, relevant tools for management and assessing individual and environmental rights have been located. We intend to foster pubic participation in the governance of their environment by exposing them to their rights established under the recently enacted GOK Environmental Coordination and Management Act (2002) and other GOK acts and laws governing use, rights, standards, and responsibilities for the management of watershed resources and improvement of economic security. To date, a preliminary extraction and summary of relevant sections has been prepared as the basis for further discussions and dialogue with stakeholders on their practical administration, effectiveness, and implementation.

Humanitarian Assistance. Aside from the short- and long-term objectives of enhancing people's livelihoods, there is no humanitarian component to this research.

Leveraged Funds and Linked Projects

University of Wyoming Global Perspectives Program: $1,500.
University of Wyoming International Travel Grant: $2,000.
University of Wyoming Graduate Student Assistantship.
University of California Graduate Student Assistantship.
Utah State University–Data sharing and project facilitation with the GL-CRSP PARIMA project.
Montana State University – Research linkage with the Trade-Off Analysis Project (Soils CRSP-funded project).
Kenya Wildlife Service–Research and facilitation linkage.
Kenya Agricultural Research Institute–Research and outreach linkage.
Egerton University–Data and information-sharing linkage with Agricultural Research Library (Rockefeller-funded project).
Friends of Mau Watershed–Information and outreach linkage.
Lake Naivasha Riparian Conservation Committee–Information and outreach linkage.

Training

In Progress

Tracy Baldyga, M.S., 2003, Rangeland Ecology & Watershed Management, University of Wyoming.
Stephen Huckett, Ph.D., 2006, Forest, Range, and Wildlife Sciences, Utah State University.
Luke Kessei, M.Sc., 2003, Environmental Science, Egerton University.
Samuel Kibichii, M.Phil., 2003, Fisheries Management, Moi University.
Joseph Kiragu, M.Sc., 2003, Environmental Science, Egerton University.
Timothy Krupnik, M.S., 2003, International Agricultural Development and Resource Management, University of California-Davis.
Charity Munyasya, M.Sc., 2003, Natural Resources, Egerton University.
Elijah Oyoo, M.Phil., 2003, Fisheries Management, Moi University.
Godfrey Ndonye, M.Sc., 2003, Environmental Science, Egerton University.
Peter Muriuki, M.Sc.,2003, Environmental Science, Egerton University.
Henry Sumba, M.Sc., 2003, Environmental Science, Egerton University.

Non-degree

University & research exposure visit to U.S. institutions - William Shivoga, Francis Lelo, Charles Maina-Gichaba. June 23 - July 5, University of Wyoming and Utah State University.
International Rangeland Congress, Durban, South Africa. Stephen Huckett, Utah State University, July 26 - August 1.

Collaborating Personnel

United States of America

Marion Jenkins, University of California-Davis
Scott Miller, University of Wyoming
Sian Mooney, University of Wyoming

Kenya

Simion Cheruiyot, Egerton University
Lois Chiuri, Egerton University
Nancy Gitonga, Fisheries Department

Shadrack Inoti, Egerton University
Francis Lelo, Egerton University
David Liti, Moi University
Simon Macharia, Fisheries Department
Charles Maina-Gichaba, Egerton University
Mucai Muchiri, Moi University
Kenya Ndettei, Kenya Wildlife Service
J.F.E. Odanga, Moi University
Jethro Onyando, Egerton University
Desterio Ernest Ouma, Egerton University
William Shivoga, Egerton University

Collaborating Institutions

United States of America

Montana State University
Dept. of Ag. Economics and Economics
P.O. Box 172920
Bozeman, MT 59717-2920

University of Wyoming
Department of Renewable Resources
P.O. Box 3354
Laramie, Wyoming 82071-3354

University of California – Davis
Dept. of Civil & Environmental Engineering
One Shields Avenue
Davis, CA 95616

Utah State University
Dept. of Forest, Range, and Wildlife Sciences
5230 Old Main Hill
Logan, UT 84322-5230

Kenya

Egerton University
Department of Environmental Science
P.O. Box 536
Njoro, Kenya
Phone: 254-037-62185

Moi University
Department of Fisheries
P.O. Box 3900
Eldoret, Kenya
Phone: 254-321-63111

Fisheries Department
P.O. Box 12912
Nakuru, Kenya
Phone: 254-037-41123/4

Kenya Wildlife Service
Lake Nakuru National Park
Nakuru, Kenya

Publications, Abstracts, and Presentations

Shivoga, W.A., F. Lelo, C. Maina-Gichaba, M.W. Jenkins, and S.N. Miller. 2002. Integrated Stakeholder Participation and Watershed Assessment in the River Njoro Watershed, Kenya. Poster Presentation to the Global Livestock Collaborative Research Program Conference, October 9-12, 2002, Washington, D.C.

Miller, S.N., W.A. Shivoga, F. Lelo, C. Maina-Gichaba, M. Muchiri, and M.W. Jenkins. 2002. Multidisciplinary Research for Sustainable Management of Rural Watersheds: the River Njoro, Kenya. Oral Presentation to the Global Livestock Collaborative Research Program Conference, October 9-12, 2002, Washington, D.C.

Huckett, S., D.L. Coppock, W.A. Shivoga, F.K. Lelo, and S.N. Miller. 2003. Comparing processes of stakeholder participation in community-based watershed programs: the Little Bear River, Utah, USA, and River Njoro, Rift Valley Province, Kenya. VII International Rangeland Congress. July 26th – August 1, 2003, Durban, South Africa.

Principal Investigators

United States

Lead Principal Investigator. Scott N. Miller, Ph.D., Department of Renewable Resources, University of Wyoming, Laramie, WY, 82071. Phone: 307-766-4274; Fax: 307-766-6403; Email: snmiller@uwyo.edu.

Co-Principal Investigator. Marion Jenkins, Ph.D., Civil & Environmental Engineering, University of California, Davis, Davis, CA, 95616. Phone: 530-754-6424; Fax: 530-752-7872.

Kenya

Host Country Principal Investigator. William A. Shivoga, Ph.D., Department of Natural Resources, Egerton University, P.O. Box 536, Njoro, Kenya.

Co-Principal Investigator. Francis Lelo, Ph.D., Department of Natural Resources, Egerton University, P.O. Box 536, Njoro, Kenya.

Co-Principal Investigator. Charles Maina-Gichaba, Ph.D., Egerton University, P.O. Box 536, Njoro, Kenya.

Co-Principal Investigator. Mucai Muchiri, Ph.D., Moi University, P.O. Box 3900, Eldoret, Kenya.

Integrated Assessment of Pastoral-Wildlife Interactions in East Africa: Implications for People, Policy, Conservation, and Development in East Africa

Narrative Summary

During 2002-03, the POLEYC project continued to develop and disseminate information requested by decision-makers in East Africa for their use in balancing the needs of wildlife conservation with the needs of pastoral land users, while ensuring the sustainability of semi-arid ecosystems in Kenya and Tanzania. Our approach is to combine geographic information system (GIS) technology with computer simulation models of the ecosystems (including the pastoral households which are part of them) to perform integrated assessments (IAs) of our study areas. These IAs predict the likely outcomes of possible future actions or events such as human population growth, animal disease control, changes in livestock stocking rates, etc. on wildlife, pastoral livestock, pastoral well-being, and ecosystem health. We have made progress on a variety of activities during the current year.

Research

Activity One: Influencing Policy

Objective a: Develop an analysis of the important legislation and policies affecting natural resource management in the pastoral areas of Kenya.

This objective was deleted. Our plan to influence policy was envisioned as the beginning of a multiple year activity. We have learned that policy change cannot be affected in a short time span. It requires building linkages to policymakers and providing information to constituencies who, in turn, approach the policy makers with their desires. With the news that our project was to be terminated, we felt that our investment in this area would not come to fruition in the time remaining. Instead, we believe that we can have more impact on policy by completing our integrated assessments and disseminating those results. The assessments that we complete will be useful to policy makers after our project has ended.

Objective b: Hold meetings in Dar es Salaam and Nairobi with USAID Mission personnel and important national level policymaking organizations.

Several meetings were held in Kenya and Tanzania to meet this objective. In November 2002, Dave Swift and Mike Coughenour had a one-day meeting in Dar es Salaam, with representatives of the Tanzania Wildlife Division (TANAPA) and the Institute of Resource Assessment from the University of Dar es Salaam. There we presented our general approach, the results from Ngorongoro, and our plans for Tarangire/ Manyara.

In January 2003, POLEYC personnel met with 23 individuals from 13 East African organizations, all stakeholders in the Kajiado area, to present results of our work there (see Activity 3, Objective b).

Objective c: O. Ole Kamuaro will meet with the Kenya Pastoral Forum to gather their input on scenarios to be analyzed at Kajiado, and help to plan a workshop for Members of Parliament from the pastoral areas and their staffs. Hold workshops for pastoral zone Members of Parliament in Kenya. Describe the results of IA at Kajiado and discuss problems and possible solutions in the pastoral areas relating to wildlife conservation, human well-being, and ecosystem integrity.

This objective was deleted for the same reason as above.

Objective d: Hold workshop for pastoral zone members of Parliament in Tanzania. Describe the results of the IA at the Ngorongoro Conservation Area (NCA) and discuss problems and possible solutions in the pastoral areas relating to wildlife conservation, human well-being, and ecosystem integrity.

This objective was deleted for the same reason as above.

Activity Two: Integrated Assessment for the Ngorongoro Conservation Area, Tanzania

Objective a: Address any questions or issues arising from the integrated assessment results.

No new questions or issues arose following our presentation of the IA results.

Objective b: Gather insights into outstanding problems amenable to integrated assessment results.

No new outstanding problems were identified. The problems addressed by the original IA for this area included the concerns of all of the stakeholders in the NCA area, and they appear to be satisfied with the results and our various presentations of them.

Objective c: Assess, and where possible, quantify, the influence of POLEYC results upon policy development.

This area is still not clear. It is uncertain to what extent the NCA will respond in a thoughtful manner to our results and to what extent their decisions are driven by outside forces associated with their Board of Directors and the area's designation as a World Heritage Site.

Activity Three: Integrated Assessment of the Amboseli Group Ranches, Kajiado District, Kenya

Objective a: Complete field studies and integrate results into IA for Amboseli; i.e., attitudes towards wildlife and pastoral impacts on vegetation patterns.

Attitudes towards wildlife. In order to quantify local intensities of wildlife-people conflicts, records of conflicts are being kept by locally hired enumerators in five areas. The positions of the locations of wildlife-people conflicts are currently being taken by global positioning systems (GPS). Preliminary interviews with focus groups and key informants were carried out. The purpose was to gather information on the local types of human-wildlife conflicts, animal species involved, land users' strategies to minimize the costs of wildlife, and sources and types of economic benefits from wildlife and tourism in the study areas. Ninety-six Maasai household heads and 96 of their dependents were randomly selected for interviews. This sample was stratified by land use, age, and gender. These interviews are now in progress.

Pastoral impacts on vegetation patterns. Fieldwork in Kajiado focused on describing the impacts of landscape fragmentation through sedentarization, altered grazing and land-use patterns, and subdivision on vegetation and wildlife as well as the sustainability of pastoral production in the group ranches north of Amboseli National Park. We continued to expand our mapping of natural resources including water points, olopololi (grazing reserves), and settlements using GPS receivers. Data on the effects of settlements on wildlife and vegetation were collected using dung counts and pin frames, respectively. The effects of fragmentation on livestock movements, pastoral production, and losses were documented through individual interviews and intensive herd following.

Study sites were arrayed along a gradient of sedentarization and subdivision running north from Amboseli National Park, including Olgulului/Lolarashi, Eselenkei, and Osilalei Group Ranches. Natural resources, settlements, seasonal movement patterns, and land-use characteristics were mapped at each site in conjunction with research conducted by Shauna BurnSilver. We are in the process of analyzing differences in land-use patterns and sedentarization between sites and also using recorded historical patterns in order to assess the relative effects of subdivision and key resources (e.g., water) on the observed spatial and temporal patterns of settlement and land-use. One of the primary components of fragmentation in the arid rangelands of Kajiado is the spatial and temporal distribution of settlements. In order to document the effects of settlements on the rangeland resource-including both vegetation and wildlife-we established 10X20 meter plots along transects radiating from both current and abandoned settlements of different ages in Eselenkei Group Ranch. We collected animal dung within all plots at monthly intervals over a year to determine the local level effects of settlement on the utilization patterns and distribution of wildlife and livestock over time. These results will then be analyzed in conjunction with aerial counts of wildlife to determine the effects of changes in settlement patterns on wildlife and livestock at multiple scales. Impacts on vegetation composition were recorded for each plot along the transects using pin frames.

Initial analyses of the ecological field work in Kajiado suggest that fragmentation and sedentarization are having a significant impact on the spatial and temporal patterns of settlement and grazing with important implications for wildlife, vegetation, and livestock. Settlement patterns tend towards increasing aggregation in intact group ranches, as resources become limiting in the face of human population growth and sedentarization around infrastructure points and key resources. With subdivision, and the erosion of communal controls on distribution, settlements disperse across individual parcels creating a blanket of human impact across the landscape. Both of these patterns contrast sharply with the more fluid historical patterns of settlement, and result in two divergent processes at the landscape level: 1) polarization of the landscape due to extremes of use and disuse; and 2) an homogenization of the landscape with dispersed human disturbance. The dynamic shifting mosaic of settlement, so characteristic of pastoralism in the absence of fragmentation and sedentarization, is lost in both scenarios and the results are evident in the area's vegetation composition-key species disappear with intensive use and woody vegetation expands in the absence of settlement. This is clearly revealed in our initial analyses of transect level vegetation patterns, where we see that dynamic settlement

results in both a temporal and spatial mosaic. Wildlife appear to respond to the current and lingering effects of human settlement at multiple scales. Initial results also suggest that subdivision has an impact on mobility patterns in response to within- and between-year variability.

Objective b: Meet with other stakeholders (e.g., both government and non-governmental agencies) in the Amboseli area who are working to impact the course of subdivision; map their approaches, clarify the common research, dissemination, and policy impact roles of each group in the overall process. If appropriate, integrate their approaches to managing the process of subdivision into the IA scenarios developed by POLEYC.

A Kajiado stakeholders meeting took place in Nairobi on January 15th, 2003 at the International Livestock Research Institute (ILRI). Twenty-three individuals attended from the following institutions and organizations: African Wildlife Foundation, African Conservation Centre, Kenya Wildlife Service, Land Use Change Impacts and Dynamics (LUCID), ILRI, the University of Nairobi, Narok County Council, Elangata Wuas, the Amboseli Tsavo Group Ranch Conservation Association, Netherlands Development Organization (SNV)-Kajiado, and members of the POLEYC GL-CRSP team.

The purpose of the workshop was to bring together a majority of the stakeholders who in collaboration with various organizations, and using a wide variety of means, are currently wrestling with the question of land fragmentation and subdivision in the Amboseli area. The POLEYC project subsequently used the results of this workshop to further refine the set of existing Integrated Assessment modeling scenarios for Kajiado. These scenarios built on the accumulated knowledge of this group of stakeholders and previous meetings with pastoralist stakeholders vis à vis the issues of subdivision/fragmentation and its potential impacts on people, the ecosystem, livestock, and wildlife in Amboseli. The group also discussed methods to leverage the ongoing efforts of the representative groups to better disseminate research results to the wider community of pastoralists at the local level and policy makers at the district and national levels. It was agreed that POLEYC would disseminate the results of the IA scenarios to each of the stakeholders present, and further discussions on ways to leverage ongoing efforts would occur.

Objective c: Model IA scenarios for the Amboseli group ranches to illustrate trade-offs involved with different management and policy decision - disseminate results of Amboseli IA scenarios to group ranch leaders/members, important stakeholders, and groups at other POLEYC project sites.

The scenarios that were refined under Objective b included investigations concerning landscape fragmentation through subdivision, loss of access to swamps and private lands for Amboseli wildlife, conversion of Chyulu Hills grazing areas to other uses, and changes in the breeds of cattle raised. These scenarios were addressed by heavily modifying and updating a SAVANNA application prepared under the Integrated Modeling and Assessment for Balancing Wildlife Conservation and Livestock Production in a Transboundary Region of East Africa (IMAS) project, much of which occurred in the last year. Also in the last year, P. Thornton heavily modified the PHEWS model applied to NCA to better represent the complex diversification of livelihoods in

southern Kajiado District. Finally, a series of spatial data layers were prepared to represent levels of fragmentation described in the scenarios modeled, such as maps of isolated group ranches, as well as 196, 10, 5, 3, and 1 km^2 parcels.

Modeling for the scenarios was completed in 2003. The myriad of simulations that were needed (e.g., 20 replicated simulations were run for each fragmented parcel inspected) required that R. Boone prepare an optimized infrastructure for conducting SAVANNA simulations. Questions regarding the effects of fragmentation on livestock or wildlife that did not pertain directly to household welfare were modeled by R. Boone, then the infrastructure to run those simulations was provided to P. Thornton, who modified the files to incorporate PHEWS modeling to look at household effects, and repeated the simulations.

In general, fragmentation analyses demonstrated that fewer livestock could be supported on a landscape of a given area (e.g., group ranch) if that area was fragmented into small parcels. Animals that may access patchily distributed forage may be prevented from reaching high quality sites in a fragmented landscape. Elimination of access to swamps outside of Amboseli for elephants led to small changes in populations, and if all swamps disappeared, losses of elephants would be catastrophic. When Amboseli wildlife were restricted to the park through fencing of private lands, for example, wildlife numbers declined by 75% in 25 years. Conversion of the Chyulu Hills to agricultural areas caused dramatic declines in livestock populations within Imbirikani Group Ranch and beyond, but losses must be weighed against gains from the new agricultural lands. Lastly, preliminary analyses indicate that changing livestock breeds to include larger, fewer stock may increase food insecurity for Maasai. Results were disseminated to stakeholders and policy makers as described in Activity Four.

Objective d: Disseminate IA results to the range of policymakers concerned with subdivision and conservation issues explored in the Amboseli IA scenarios.

Results of the Kajiado IA scenarios were disseminated in July 2003, in a series of seven meetings across the Kajiado study area. Six meetings were open to all community members (Imbirikani, Kalesirua, Emeshenani, Lenkisim, Eselenkei, and Osilalei), and included group ranch committee members, local chiefs and subchiefs, elders, women, and warani. One meeting occurred at Kenya Wildlife Service-Amboseli Headquarters. Over 500 individuals attended the community meetings. Results were disseminated in English and then translated into Maa. The POLEYC team (S. BurnSilver, R. Boone, and J. Worden) used flip charts and maps in the presentations. IA results focused on the central issue of subdivision and alternative impacts for livestock, people, and wildlife under realistic alternatives for subdivision pathways that were identified by pastoralists and local stakeholders themselves. Questions asked of the POLEYC group after the meetings highlighted that pastoralists had not only understood the results, but found them useful in assessing the advantages and disadvantages associated with the choices facing them regarding subdivision. The results strongly highlighted the fact that there is not one set of unilateral effects associated with subdivision across all areas; instead, the impacts of subdivision differ depending on the ecology and rainfall of each individual area. These results were timely, as group ranch members

in Imbirikani, Olgulului/Lolarashi, and Eselenkei Group Ranches are preparing for votes on the subdivision issue in the near future. A non-technical version of the final report for Kajiado is being prepared, and 200 copies will be translated (into KiSwahili) and disseminated in the study areas in January 2004 (corresponding with a trip to Kenya by S. BurnSilver).

Activity Four: Integrated Assessment of the Tarangire/Manyara Ecosystem, Tanzania

Objective a: Characterize the Tarangire/ Manyara Ecosystem (TME) Landscape; create a plant community map of the region through supervised classification of a Landsat Thematic Mapper (TM) image. Use existing and new data to describe physical landscape structure.

A plant community map was created by Istituto Oikos and is available for our team's use. This negates the need to create one for this project. However, a land use/land cover change analysis will be conducted using 2-3 sequences of satellite Landsat TM images. A rudimentary analysis was conducted by Istituto Oikos, but we will perform an analysis at an increased resolution and include data from a new 2003 Landsat TM image. Funding was made available to a graduate student from the University of North Carolina to scan several topographic maps of Simanjiro, to cover the villages of Loiborsoit (the focus of her study), Emboreet, and Sukuro. These data will contribute significantly to the physical landscape structure description. The scanning is expected to be complete by the end of 2003.

Objective b: Map spatial and temporal habitat partitioning across the TME; investigate effects of various livestock management scenarios on wildlife inside and outside the park. Identify areas of current and potential wildlife-livestock conflicts.

Household interviews conducted by S. Lynn in Sukuro, and in process in Loiborsoit and Emboreet, cover the spatial and temporal aspect of wildlife-human-livestock conflicts, though analyses have not yet been completed due to her recent return from the field. Planning for the collection of ecological data on wildlife and livestock movements and densities across the villages of Sukuro, Emboreet, and Loiborsoit was completed during the 2003 field season. S. Lynn has selected areas for wildlife/livestock area counts and walking transects, and a research schedule has been drawn up. All field assistants used during the 2003 field season are available for the 2004 field season, and additional prospective hires have been explored. Actual data collection was not completed due to many logistical difficulties encountered during the upstart of that field season.

According to T. McCabe, most individuals and groups mentioned problems associated with wildlife. With respect to wildlife, wildebeest were singled out as having the greatest impact. Wildebeest calves are infected with the malignant catarrhal virus, which is infectious to cattle for the first three months following their birth. The virus is benign to wildebeest but deadly to cattle, and the only way to prevent infection is to move cattle away from the areas where the wildebeest are giving birth. While the distances moved in Simanjiro are relatively short, the necessity to move puts an additional burden on the household labor supply, especially considering that most of the people who move with the cattle are children currently enrolled in school. In addition to the wildebeest, lions and hyenas were mentioned frequently as killing livestock.

Objective c: Investigate the roles of cultivation and other land use changes in current and future TME dynamics, particularly as related to Maasai land use and wildlife conservation. Create map of current and potential cultivation. Explore whether social linkages create a socially expanded landscape.

The investigation into the roles of cultivation and other land use changes in current and future TME dynamics hinges on ecological data to be collected in the February-May 2004 wet season. Household interviews included questions related to this area of inquiry, but ecological measurements are needed for a complete analysis. Maps of current and potential cultivation will be created after classification of TM imagery, and analysis of land use/land cover change.

Land use is complicated by the privatization of land holdings, competing views of how the land should be used by people in different age groups, the rapid expansion of cultivation, and grazing areas managed at the village level. In general, people in villages located along the eastern border of Tarangire National Park keep their livestock close to their bomas (or enkangs) during the wet season and move toward the park in the dry season. Availability of water and the presence of large farms are problems and restrict the areas that livestock can use. Individuals are supposed to use grazing land within the village boundaries, but it should be noted that villages can be quite large (1000 sq. km. and larger). Labor for herding is also becoming a problem as the many young men are now engaged in agricultural pursuits, migrating to find work, and going to school.

The adoption of cultivation began in the Tarangire area in the early 1970s. The major expansion of cultivation appears to have occurred in the 1980s. The Maasai now view themselves as an agro-pastoral people, practicing a diversified livelihood strategy based on the raising of livestock and cultivation. Although livestock remains at the core of their economy, cultivation plays a very important role both in terms of nutrition and in terms of providing an income. Secondly, the ability of the Maasai in that region to act as middlemen in the Tanzanite business has provided a means by which they can invest in tractors and other agricultural inputs.

The village lands in the areas to the east of Tarangire National Park are being subdivided into individual plots. Although individuals do not hold title deeds, land allocation records are kept in each village, and the land is treated as if it is individually owned; however, there are very different views on how land should be used in the future among different Maasai ages groups. The older men would like much of the area to remain as common grazing land, open to all. The younger men tend to favor a more privatized tenure system, with individuals holding title to the land. At this time the land tenure systems appears to be in a state of flux, and that could also be influencing the rapid rate of agricultural expansion.

Objective d: Collect data for the PHEWS modeling effort; T. McCabe and S. Lynn will collect original data for PHEWS application in the TME.

A significant amount of data were collected by S. Lynn in 2003 for the PHEWS modeling effort in the village of Sukuro. Additional data are currently being collected by her research team in neighboring Loiborsoit and Emboreet villages.

Activity Five: Integrated Assessment of the Greater Meru Ecosystem

Objective a: Complete a needs assessment and analysis of the policy environment with local/ national stakeholders and establish the IA scenarios to be evaluated.

The needs assessment was not completed; however, we feel that our previous workshops and meetings were adequate to identify the important issues from stakeholders (e.g., the Ellis workshops during the Assessment Phase of the project, the Ellis, Coughenour, et al. field expedition in January 2001). We have been in good contact with Kenya Wildlife Service throughout - it is they who called for the Meru assessment. The model will be used to assess the following issues:

- Effects of land conversion to agriculture on wildlife carrying capacity.
- Consequences of fencing wildlife inside the park on their carrying capacity, andwildlife population management recommendations.
- Effects of livestock grazing north of the park on forage supplies for wildlife.
- Effects of wildlife on forage loss for livestock.
- Effects of loss of watering points for wildlife due to human and livestock utilization.
- Carrying capacity of grazing lands outside of park for livestock alone, livestock and wildlife, and wildlife alone, in various combinations. This will be assessed in terms of grazing effects on plants as well as animal forage requirements.
- Identifying potentially underutilized areas due to lack of water.

Objective b: Complete collection of field and remotely sensed data to support model applications, purchase of a TM image, vet. survey, vegetation mapping, and socio-economic data on Borana/Somali pastoralists and Meru cultivators.

A remote sensing analysis was done on 1987 and 2001 Thematic Mapper images of the Meru Conservation Area (MCA) by J. Otuoma in order to detect any landscape changes over the last two decades. Supervised classifications were carried out by the development of ground-truthed "training data sets." The vegetation in each area was characterized by percent cover of dominant plant species, sizes of plants, densities and distributions of livestock and humans, and topographic features.

Remote sensing analyses showed significant changes in land cover in the MCA's buffer zones between 1987 and 2001. On the western boundary of the Meru National Park, large areas of natural vegetation that existed mainly as open wooded grassland in the early 1980s had been taken up by migrant agricultural communities and fragmented into extensive smallholder cultivation units and human settlements. In the pastoral zones of the northern and northwestern boundaries, the vegetation structure had changed from shrub grassland in the early 1980s to bush and shrub thickets. Also notable in this zone was the development of a large herbaceous layer of forbs in between the bush and shrub thickets in areas that originally were covered with grass. This was partly attributed to overgrazing arising from a continually reducing pastoral grazing range and partly to lack of burning regimes in the pastoral areas. On the southern park boundary, areas that existed as natural bushland vegetation in the early 1980s had significantly changed to homesteads and farmlands.

A field study was carried out by J. Otuoma to assess changes in human populations, land uses, and conflicts with wildlife. Eighty

households in the Meru North and Isiolo Districts were randomly selected for a questionnaire survey. The questionnaire addressed household details, land use/land tenure, livestock production, agriculture, and wildlife/livestock/human conflicts.

Questionnaire surveys indicated that by 2002, 70% of the human population in the MCA's buffer zones were agriculturalists who arrived after 1980. The introduction of cropping agriculture alongside pastoral livestock production and wildlife management has made very demanding use of resources in this semi-arid eco-climatic zone by spatially reducing pastoral grazing fields, occupying animal home ranges, and diverting water courses from livestock and wildlife to facilitate the irrigation of agricultural plots. The situation has led to a decline in the resource base, which has increased wildlife/livestock/human interactions and led to wildlife/livestock/human conflicts related to resource access. The veterinary survey was dropped, because we felt that other researchers were covering that aspect (e.g., Jeff Mariner and Richard Kock).

Objective c: Adapt the SAVANNA/PHEWS modeling system to the Greater Meru Ecosystem (GME).

An ecosystem model-based assessment is underway, to be completed in spring 2004. This assessment will support the development of a strategic management plan for the Meru ecosystem by quantifying the impacts of alternative management, and developing procedures on wildlife restoration, ecosystem integrity, and community needs in terms of livestock production and economic status of pastoral people.

The application of the SAVANNA ecosystem model required the preparation of numerous data sets for model inputs, and for model testing. For example, the model requires weather data, GIS maps, and attribute data for soils and vegetation, human and livestock population data, wildlife population data, and vegetation biomass data in time and over space. Data were synthesized from a variety of sources.

Although the model-based assessment is not complete, we have assembled a database that will prove to be useful not only for the assessment here, but for future analyses and assessments conducted by others in the future. Such a data set did not exist until now. It includes GIS data, weather data and maps, and data on vegetation, livestock, and wildlife.

Objective d: Initiate modeling exercises of IA scenarios.

The modeling exercises have not been initiated yet, and are a major part of the work for the upcoming year.

Activity Six: Regional GIS/RS Analysis

Objective a: Establish spatial and temporal patterns and trends of range condition and degradation in Kenyan rangelands. Evaluate the state of connectivity between wildlife reserves in the Kenya-Tanzania border region. Assess trends in livestock productivity.

The project has fully supported Joyce Acen's Ph.D. studies in Ecology at Colorado State University between 1999 and 2003. Her research is focused on the long-term patterns in the condition of rangeland vegetation and regional herbivore species distribution and habitat suitability in selected pastoral regions in northern and southern Kenya. The main objective of the study was to determine spatial and temporal patterns of range condition using advanced very high resolution radiometer

(AVHRR) normalized difference vegetation index (NDVI) time series, both through analyses of vegetation response to rainfall in relation to ungulate population density and of herbivore species distribution based on multiple ecological variables in order to characterize habitat suitability for wet- and dry-season grazing. The study is ascertaining evidence of long-term degradation along the rainfall gradient represented by the four districts covered in the study and answering questions regarding evidence of range degradation in the study areas over the 18-year period, and relationships between range condition, climatic factors, and herbivore densities.

Monthly rainfall totals have been compiled for the study period, and vegetation response to rainfall (above or below expected response) is used to determine the spatial and temporal patterns of range condition. AVHRR NDVI data at 8 km. resolution from the Africa Data Dissemination Service (ADDS) data archive, averaged by month for the study period (1982–1999), are used as indicators of primary productivity and biomass quantity. Ungulate population distribution data were obtained from the Kenyan government's Department of Resource. Most were conducted at a spatial resolution of 5X5 km. Temporal patterns are examined at monthly and seasonal time scales.

Gender

This program has a fairly large number of women scientists. Most of the graduate students on the project are women (Acen, Roque de Pinho, Lynn, BurnSilver). Several of the senior investigators are as well (Galvin, Reid, Serneels). Gender issues such as access to resources and decision-making roles are addressed in our socioeconomic surveys. Contributions of women to the diversification strategies of Maasai households in Kajiado are considered in analyses. Contribution of women to diversification strategies and household economics were considered in the TME and GME as well. The attitudes of Maasai women (young and old) towards wildlife as a unique group are considered explicitly in the work of J. Roque de Pinho. Womens' groups have been targeted for outreach efforts in Kajiado because these groups have an active voice in land use management and economic decisions in the Amboseli Group Ranches.

Policy

The IA applications that we plan are very directly policy-oriented. 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, nationwide.

Outreach

Our outreach targets are many, and our approaches vary depending upon our audience. We disseminate our results to all decision-makers who have an impact on the management of the resources of the pastoral zones of Kenya and Tanzania. This includes individual pastoral herd owners and their families who make a multitude of decisions about marketing, stocking rates, animal disease control, coexistence with wildlife, and

other issues. This has been accomplished by dissemination of results of our studies in non-technical language, in written reports in KiSwahili, and in oral presentations in Maa.

We also interact with NGOs in the pastoral zones and with pastoral groups, such as the group ranch committees in Kajiado. These communications include those described above and more technical English language reports, where appropriate. We provide results that are useful for management to our institutional collaborators, such as the Ngorongoro Conservation Area Authority (NCAA) and the Kenya Wildlife Service (KWS). We are currently training Wycliffe Mutero of the KWS in the use of the SAVANNA modeling system and its application to integrated assessments. His training is going on at Colorado State University (CSU), and it is expected that KWS will incorporate the use of SAVANNA into their normal planning process. We interact with decision-makers within government ministries that are responsible for decision-making within the pastoral zones. These communications take the form of face-to-face meetings and workshops designed to describe our IA approach and the results we have obtained. We maintain open communications with the USAID Missions in both countries, briefing them on our work and providing them with our reports. We continue to develop Research Briefs, suitable for most of the non-technical audiences mentioned above.

Developmental 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 have 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 in weighing 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.

Environmental Impact. The project improves the environment by suggesting management options that will maintain or improve grazing conditions and balance wildlife and livestock uses.

Agricultural Sustainability. The IA approach that we use, incorporating the SAVANNA modeling system, is able to emulate long-term ecosystem dynamics, enabling us to determine if specific management actions are likely to lead to sustainable resource exploitation strategies.

Contributions to U.S. Agriculture. Lessons learned in studying the semi-arid systems of East Africa can and do shed light on management problems in semi-arid systems in the U.S. In particular, techniques for mitigating wildlife/livestock conflicts are applicable to situations in the U.S. where similar conflicts exist.

Contributions to Host Countries. We are assisting the resource management agencies of Kenya and Tanzania with planning for land management in areas where wildlife and livestock are in potential conflict. Our results should assist the host countries in the development of management plans that will improve wildlife conservation and pastoral well being.

Linkages and Networking. We have developed important working linkages with many governmental, parastatal, and non-governmental agencies in both countries.

Collaboration with International Research Centers (IARCs) and CRSPs. One of our most important collaborators in the project is ILRI. We work closely with Robin Reid, Philip Thornton, and Mrigesh Kshatryia of that organization, among others, on many aspects of the project.

Other Contributions

Support for Free Markets and Broad-Based 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 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 policymakers, a cornerstone function of democracy.

Leveraged Funds and Linked Projects

The following projects contributed leveraged funds to the POLEYC project during the period October 1, 2002-September 30, 2003.

National Science Foundation – PI: Niall Hannan. "Biocomplexity in African Savannas." Project Period: 5/02-5/06. Project uses SAVANNA Ecosystem Model to model interactions among soils, vegetation, fire, and herbivory in African savannas. Model parameterization and testing 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 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 (Natural Resource Ecology Laboratory/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.

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.

Training

During the last funding year, we supported six Ph.D. students and one M.S. student. We hosted a number of non-degree training workshops in Kenya and Tanzania, as well as dissemination meetings, and training at CSU for one Kenyan scientist in SAVANNA and IA methodology.

In progress

Joyce Acen, Ph.D. student, 2003, Ecology, Colorado State University.

Jeff Worden, Ph.D. student, 2003, Ecology, Colorado State University.

Shauna BurnSilver, Ph.D. student, 2003, Human Ecology, Colorado State University.

Stacy Lynn, Ph.D. student, 2004, Ecology, Colorado State University.

Joana Roque de Pinho, Ph.D. student, 2004, Human Ecology, Colorado State University.

John Otuomo, M.S. student, 2004, Botany, University of Nairobi.

Oltisatti Kamuaro, Ph.D. student, 2004, Range Ecology, University of Nairobi.

Non-degree

Stacy Lynn, U.S., Swahili course, Tanzania.

Wycliffe Mutero, Kenya, 4 months training at CSU on use of SAVANNA modeling.

Collaborating Personnel

United States of America

Michael Coughenour, S. Research Scientist, NREL.

Kathleen Galvin, S. Research Scientist, NREL.

Randall Boone, Research Scientist, NREL.

Shauna BurnSilver, Project Manager and Ph.D. Candidate, NREL.

James DeMartini, Professor, CSU.

Terrance McCabe, Professor, University of Colorado.

Jeff Worden, Ph.D. Candidate, NREL.

Stacy Lynn, Ph.D. Candidate, NREL.

Joana Roque de Pinho, Ph.D. Candidate, NREL.

ILRI

Robin Reid, Senior Systems Ecologist.

Philip Thornton, Research Scientist, ILRI, Nairobi, and Edinburgh, Scotland.

Meshak Nyabenge, GIS Analyst.

Joseph Ogutu, Ecologist and Modeler.

Leah Muraya, Data Analyst.

Mrigesh Kshatriya, Ecosystem Modeler.

Suzanne Serneels, Geographer, Remote Sensing.

Russ Kruska, GIS Lab Leader.

Kamau Kimani, Project Manager and Geographer.

Kenya

Jenesio Kinyamario (Kenyan PI), Professor, University of Nairobi, Dept. of Botany.

John Mworia, Research Associate, University of Nairobi.
John Otuoma, M.S. student, University of Nairobi, Dept. of Botany.
Jesse Njoka, Professor, University of Nairobi.
Stephen Mbogoh, Professor, Univ. of Nairobi.
Mrigesh Kshatriya, Research Scientist, ILRI.
Kamau Kimani, Research Associate, ILRI.
Jackson Wandera, Land Use Planning Coordinator, SARDEP.
Wilber Ottichilo, Director General, RCMRD.
David Western, Director, ACC.
Jan Grootenhuis, Veterinarian, Private Consultant.
Paul Rwambo, Veterinarian, Private Consultant.
Richard Bagine, Research Director, KWS.
Wycliffe Mutero, GIS Leader, KWS.
Michael Kipkeu, Senior Warden, Amboseli NP.
Mark Jenkins, Senior Warden, Meru NP.
P. Ole Kamuaro, Assistant to the Director, Natural Environmental Secretariat, and Ph.D. Candidate, Univ. of Nairobi.
Nick Georgiadis, Director, Mpala Research Centre.
James Likampa, Group Ranch Representative, Imbirikani.
David Salaash, Group Ranch Representative, Eselengei.
Leonard Partimo, Group Ranch Representative, Olgululuri/Lolarashi.
Ole Sitaya, Group Ranch Representative, Osilalei.
Joseph Miaron, Manager, Amboseli/Tsavo Group Ranch Conservation Association.

Tanzania
Alan Kijazi (Tanzanian PI), Acting Conservator, NCAA, Ngorongoro.
Victor Runyoro, Chief Ecologist, NCAA, Ngorongoro.
Emmanual Chausi, Conservator, NCAA, Ngorongoro.
Emmanual Gereta, Consultant to TANAPA.
Angello Mwilawa, Livestock Research Scientist, LPRI, Mpwapwa.
Francis Ole Ikayo, Director, Inuyat e-Maa.
Peter Toima, Director, Maasai Advancement Association, Arusha.
Carol Sorensen, ERETO, Ngorongoro.
Gaspar Leboy, ERETO, Ngorongoro.
Cuthbert Nahonyo, Professor, University of Dar es Salaam.
Elifuraha Mtalo, Director, UCLAS.
Patricia Moehlman, Private Consultant.
Fatheem Banyikawa, Research Scientist, SUNY and Serengeti Research Institute.

Uganda
Joyce Acen, Ph.D. Candidate, NREL.

Collaborating Institutions

Kenya
International Livestock Research Institute, Nairobi
University of Nairobi
Kenyatta University, Nairobi
Kenya Agricultural Research Institute, Nairobi
Kenya Wildlife Service, Nairobi
Regional Centre for Mapping of Resources for Development, Nairobi
National Environment Management Authority, Nairobi
Mpala Research Centre, Nanyuki
Amboseli/Tsavo Group Ranches Conservation Association, Loitokitok
Semi-Arid Regional Development Program, Kajiado
African Conservation Centre, Nairobi
PACT CORE, Nairobi
SOFRECO, Clichy, France (working in GME)
African Wildlife Foundation, Nairobi

Tanzania
University of Dar es Salaam
Ngorongoro Conservation Area Authority, Ngorongoro
Inuyat e-Maa, Arusha
African Wildlife Foundation, Arusha
Tanzanian National Parks, Arusha
Livestock Production Research Institute, Mpwapwa
Ngorongoro Conservation Area Authority, Ngorongoro
University College of Lands and Architectural Studies, University of Dar es Salaam
Executive Pastoral Council, Ngorongoro
Istituto Oikos, Verese, Italy (working in TME)

Publications

Research Briefs

Boone, R.B. and S.B. BurnSilver. In press. Assessing effects of landscape fragmentation using normalized difference vegetation indices. Research Brief by the Global Livestock Collaborative Research Support Program, University of California, Davis.

Swift, D.M. and R. B. Boone. In press. Effects of cultivation within Ngorongoro Conservation Area, Tanzania. Research Brief by the Global Livestock Collaborative Research Support Program, University of California, Davis.

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Coughenour, M. 2002. Ecosystem Modeling in Support of the Conservation of Wild Equids - The Example of the Pryor Mountain Wild Horse Range. IUCN Equid Specialists Group Report. IUCN. Gland, Switzerland. (In press).

Coughenour, M. The Ellis Paradigm: balance humans, herbivores, and rangeland systems. African Journal of Range and Forage Science (in press).

BurnSilver, S., R.B. Boone and K.A. Galvin. 2003. Linking pastoralists to a heterogeneous landscape: the case of four Maasai group ranches in Kajiado District, Kenya. In: People and the Environment: Approaches for Linking Household and Community Surveys to Remote Sensing and GIS. J. Fox, R.R. Rindfuss, S.J. Walsh, and V. Mishra, eds., Kluwer Publ., Boston.

Runyoro, A.V., K.A. Galvin, P.K. Thornton, S.J. Lynn, and J. Sunderland. 2003. Livelihood strategies: the Maasai pastoralists of Ngorongoro Conservation Area. Proceedings of the Tanzania Wildlife Research Institute Annual Meeting, Arusha, Tanzania.

Thornton, P.K., K.A. Galvin, and R.B. Boone. 2003. An agro-pastoral household model for the rangelands of East Africa. Agricultural Systems 76:601-622.

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Boone, R.B. and N.T. Hobbs. Lines around fragments: effects of fencing on large herbivores. International Rangelands Congress. July 2003.

BurnSilver, S. 2003. Land Use and Impacts of Ongoing Fragmentation in a Pastoral Landscape: An Example from Four Maasai Group Ranches, Kajiado District, Kenya. Poster Presented at VIIth International Rangelands Congress, Durban, South Africa.

Coughenour, M. 2003. The Ellis Paradigm: balance humans, herbivores, and rangeland systems. Presented July 31, 2003 at: Symposium on the SCALE Project-a tribute to Jim Ellis. VIIth International Rangelands Congress, Durban, South Africa.

Coughenour, M., R. Boone, K. Galvin, P. Thornton. 2003. Integrated modeling and assessment systems for balancing food

security and wildlife in East Africa. Presented July 30, 2003 at: Symposium on Conservation, Farming, and Integrated Land Use: optimizing the overall benefit of land use options for people and the environment, VIIth International Rangelands Congress, Durban, South Africa.

Coughenour, M. 2003. Rocky Mountain, Yellowstone, and Serengeti National Parks: Spatial Ecosystem Modeling and Integrated Assessments of Interactions Between Humans and Natural Systems. Presented October 8, 2003 at: Beyond the Arch: Community and Conservation in Greater Yellowstone and East Africa. Yellowstone 7th Biennial Scientific Conference, Mammoth Hot Springs, Wyoming. Oct. 6-8, 2003.

Galvin, K.A., P.K. Thornton and R.B. Boone. Climate Variability, Spatial Scale and Impacts on East African Livestock Herders. International Rangelands Congress. July 2003.

Galvin, K.A. 2002. Use of integrated assessment for balancing food security, conservation, and ecosystem integrity in the rangelands of East Africa. Paper presented at the University of Wyoming Seminar Series in the Department of Anthropology. November 13.

Galvin, K.A. 2002. Integrated assessment of pastoral-wildlife interactions in East Africa. Socioeconomic considerations and socioeconomic modeling. Paper presented at the Global Livestock CRSP Program Conference, Washington, D.C., October 8-12.

Galvin, K.A., R.S. Reid, S. BurnSilver, and R.B. Boone. 2002. Linking communities and households to climate variability and land cover/land-use change at different scales in farming and pastoral systems of East Africa. Paper prepared and presented by R.S. Reid for the Workshop on Linking Household and Remotely Sensed Data: Methodological and Practical Problems, East-West Center, Honolulu, January 3-8, 2002.

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McCabe, J. Terrence. Conservation and Indigenous Peoples: Challenges for New Leadership in Protected Areas. Paper presented at the 100th annual meeting of the American Anthropological Association. New Orleans. Nov. 20-24, 2002.

Principal Investigator

Lead Principal Investigator. David Swift, Senior Research Scientist, Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, CO 80523. Phone: 970-491-1981; Fax: 970-491-1965; Email: davesw@nrel.colostate.edu.

Livestock Marketing in Kenya and Ethiopia

Narrative Summary

Livestock marketing is critical to the development of arid and semi-arid lands in Kenya and Ethiopia. Donors are showing renewed interest in funding livestock marketing activities. Livestock market improvement offers the potential to reduce poverty in areas that are identified as the poorest in these countries. Such activities also allow donors to move from a "relief" mode to a "development" mode in dryland areas, as there is growing frustration with dryland activities being in permanent "relief" mode. However, the research community is not currently able to provide donors with clear and specific information to use in designing livestock marketing activities. It is not at all clear how research findings at the macro, meso, and micro levels are to be reconciled and used in program design. It is also not clear how markets should be designed to meet marketing needs in both "normal" and "crisis" periods. At this point in time, it is difficult to provide specific recommendations based on research to donors.

What is missing is an overall sense of how interventions at different levels and for different states of the world fit together, how they should be prioritized, and how they should be sequenced. While changes at all levels are needed, where should we start? How will changes at one level influence changes at a different level? Are any types of interventions pre-conditions for success of other interventions? Most specifically, can we be sure that changes in the market structure at higher levels will lead to poverty reduction at the household level? Can we be sure that potential benefits to changed market conditions at the local level will not be unobtainable due to blockages at higher levels? Can we identify policies at the international level that will encourage trade, or are currently inhibiting trade? Can we be sure that market interventions designed for normal times are flexible enough to address needs in crisis periods? The goal of this project is to gather together researchers working on livestock marketing in Kenyan and Ethiopian marketsheds to begin developing an understanding of these issues, and how these marketsheds are influenced by larger regional and international factors. The outcome will be the publication of these various insights, and the provision of a set of recommendations to donors interested in livestock market development.

Research

The goal of the program was to prepare for a workshop on livestock marketing in East Africa, hold this workshop, and conduct targeted follow up research following this workshop. We take each of these in turn.

Preparing for the workshop. We conducted a literature review in the United States to identify who was currently working on issues of livestock marketing in Kenya and Ethiopia, and completed an annotated bibliography that summarized works we were able to obtain and noted other works that were possibly relevant but not able to be obtained

(largely government reports and project documents fell into this category). We used the results of the literature review to identify researchers involved in livestock marketing in East Africa. We invited these researchers and some selected policy makers to meet at a workshop where livestock marketing would be discussed (see Collaborating Personnel for a list of participants).

Conducting the Workshop. Thematically, we divided the discussions into four different topics. We first considered issues of household level marketing. We then discussed issues related to crisis period marketing. The third topic considered was market level issues at the local and sub-area (district or regional) level. Finally, we considered national and international issues of livestock marketing. For each topic, we first discussed what is already known on this topic, and then discussed what needs to be known. These discussions were particularly enlivened by having both researchers and practitioners involved in the workshop, and this helped to steer research priorities to topics of practical and timely importance. We concluded the workshop by an exercise in which the participants ranked research priorities. In this summary, we discuss the top three priorities as examples, and refer the reader interested in the overall ranking of priority topics to the details contained in the workshop proceedings (available via email from the PI and on the GL-CRSP website, http://glcrsp.ucdavis.edu). The highest research priority was to develop understanding of whether interventions (provision of market information, trade intelligence, weather information, definition of market standards, etc.) influence household level decisions to market livestock in the context of increasing understanding of the overall process of how households decide to sell livestock. The second highest priority was to understand how externally funded market-based crisis interventions can be made compatible with traditional crisis coping strategies. The third highest priority was to investigate what can be learned from studying market cooperatives and marketing partnerships that are successful and those that have failed to understand both the potential and the pitfalls that confront such organizational responses to inefficiencies in the established marketing chain. We hope to be able to follow up on these priorities by defining and implementing research projects that investigate these and other priority topics.

Targeted Follow-Up Research. The original timeline for this project called for targeted studies to be conducted following the workshop and taking place within fiscal year (FY) 03; however, this was not possible due to the need to reschedule the workshop as detailed below. We now hope to undertake these activities in FY 04.

Progress. The main impediment to the project's progress was due to rescheduling the workshop from March 2003 until August 2003. The original date was not feasible due to security concerns that arose during the buildup to the Iraq war. Both workshop participants and, more importantly, embassy representatives in Nairobi expressed concern about holding a high profile workshop during this period. This was especially true as the workshop was originally scheduled to be held on the USAID grounds in Nairobi. In light of these concerns, we rescheduled the workshop to the next feasible date that would ensure the maximum participation level, which turned out to be mid-August. This caused us to modify our original workplan to keep the preparation for the workshop and the workshop in FY 2003, while moving the targeted studies and publication of the targeted studies into FY 2004.

Gender

There was no specific gender component to the project over the past year. Topics identified as meriting further research did, in some cases, have a gender component.

Policy

The project brought local level non-governmental organization (NGO) representatives to the workshop in Nairobi. The goal was to have these front line development actors discuss with researchers both what is known about livestock marketing and what needs to be researched to help them better serve the population in the area they work. The benefit of this interaction was twofold. One, researchers were able to hear from front line agencies what they are being asked to do by donors, and were able to provide guidance based on previous research on how best to meet these demands and also identify where further research would be needed to help them meet these demands. Two, development agents were able to obtain advice and be updated on the latest research findings that were not likely to be available to them in the rural areas where they are based. With regard to national policy, the project is still in its early phase, so there is little to report in terms of outcomes. However, we can say that the Livestock Marketing Authority in Ethiopia and the Livestock Marketing Council in Kenya were active and engaged in our workshop, and the relevant ministries have been advised of our project and our deliberations in August.

Outreach

The project did not have an outreach component as it was in its initial year.

Developmental Impact

Environmental Impact. There was no environmental impact in this initial year. Looking toward the future, if we accept that livestock accumulation and low sales rates have an adverse environmental impact, improving market efficiency should reduce pressure on rangeland resources. If we do not accept that this is the case, then the environmental issues become how we design market institutions that do not create a negative environmental impact. The connection between stocking pressure and environmental degradation is currently under some debate in arid and semi-arid environments, and we are not convinced of the contention that widespread grazing-induced degradation is occurring. However, we are convinced that designing market interventions has to be done carefully with an eye towards preventing unintended adverse environmental consequences. This was a topic of our discussion at the Nairobi workshop particularly as it pertained to designing and implementing crisis period and recovery from crisis period strategies.

Agricultural Sustainability. Livestock marketing is a good example of the type of intervention that is extremely sustainable over time. Livestock marketing exists in the area, and has existed for quite some time. Clearly people are buying animals produced in livestock raising areas, and clearly people in livestock raising areas are selling animals in the market. The question is how do we reduce inefficiencies in this market to improve market functioning and improve the well-being of agricultural producers. There are very few physical inputs required, and not all that many capital costs. It is a question of finding out what is working, and identifying how to build upon success and eliminate inefficiency. The

project is an attempt to use research as a tool to identify such opportunities, and the approach of working with policy makers is the strategy we have chosen to ensure the findings have an impact on the ground.

Contributions to U.S. Agriculture. There were none over the past year. As the project continues to develop, there may be new information on market efficiency or crisis period mitigation that have some relevance to U.S. livestock production areas.

Contributions to Host Country. We held our workshop in the region and used the national carrier for transport between Ethiopia and Kenya. Looking toward the future, livestock-raising areas tend to be the poorest areas of East Africa. To the extent that we can identify ways to raise living standards by improving market efficiency, we will be identifying ways to improve well being without imposing great costs.

Linkages and Networking. There is currently a great deal of interest in livestock marketing. Various organizations including the European Union (EU), the Food and Agriculture Organization (FAO), USAID, the International Livestock Research Institute (ILRI), and the International Food Policy Research Institute (IFPRI) have recently launched initiatives in livestock marketing. Both Kenya and Ethiopia are showing renewed interest in livestock marketing as a matter of national policy. GL-CRSP has a long history of working in the pastoral areas at the community level, and is specially placed to represent this local level perspective on livestock marketing issues. Particularly as large, national, or international policy initiatives are launched, we will be well-placed to work with these organizations to help identify what will be the local level impact of these policies, and how can we ensure that local producers capture some of the economic benefit the policies generate.

Collaboration with International Research Centers (IARCs) and other CRSPs. As noted in the preceding point, both IFPRI and ILRI are turning toward livestock marketing, and we have established linkages with them and have a particularly strong link with ILRI researchers. We work in close collaboration with the GL-CRSP PARIMA project, as the core members of the LiTEK project are all PARIMA members. In addition, we work with the GL-CRSP Livestock Eearly Warning System (LEWS) project, as we share an interest in improving market efficiency. LEWS is particularly interested in the role of information delivery in marketing, and we have discussed this issue with LEWS representatives quite a number of times.

Other Contributions

Support for Free Markets and Broad-Based Economic Growth. This is a project based on improving free markets by identifying and reducing inefficiencies through targeted research. Livestock raising is the key economic activity in arid and semi-arid areas. Improving livestock marketing offers the only viable potential base for a future of broad-based economic growth in this area. While other activities will undoubtedly be important to the economic future of arid and semi-arid areas, none will be possible without ensuring the health of the core economic activity of livestock raising and marketing. We have begun by prioritizing research activities for this sector.

Contributions to and Compliance with Mission Objectives. USAID is trying to move interventions in pastoral areas from "relief mode" to "development mode." They are looking at ways to ensure that mission activities contribute to building a viable economic future that prevents humanitarian

crises, rather than addressing immediate humanitarian needs in ways that do not head off future crises. That is also the aim of this project.

Concern for Individuals. Livestock marketing offers a way to build an economic future for areas that are the poorest of the poor, and are marginalized in the national economy. We are identifying ways to improve the economic opportunities facing the individual livestock producer, and also the prospects for other individuals involved in different parts of the marketing chain.

Support for Democracy. There is nothing explicitly in the project that addresses support for democracy.

Humanitarian Assistance. The research focuses on how livestock markets function during crisis periods and also how markets function to help people recover from crisis periods. The goal is to identify how to use market-based interventions to minimize the need for humanitarian assistance that takes place outside normal marketing channels. This will both increase the sustainability of future crisis period interventions and reduce their unintended impacts on market functioning.

Leveraged Funds and Linked Projects

We cooperated with the PARIMA project, as the key members of the LITEK project are also PARIMA members.

Training

There was no training component of this project.

Collaborating Personnel

The lead investigator on the project over the past year was John McPeak at Syracuse University. He was assisted by Peter Little at the University of Kentucky and by Chris Barrett at Cornell University. Getachew Gebru handled the in-country work in Ethiopia for this project. Getachew is the post doctoral research associate for the PARIMA project. The following is a list of individuals who attended the workshop:

Abdi Hussein Abdi, Kenya Livestock Marketing Council.

Abu Abikar, FAO-Support to Livestock Export in the horn of Africa (EXCELEX-HOR).

David Acker, Iowa State University.

Teressa Adugna, Alemaya University.

Yacob Aklilu, Organization of African Unity-Interafrican Bureau for Animal Research (OAU-IBAR)/Tufts University.

Dadhi Amosha, Oromia Pastoral Development Commission.

Metalign Ayehu, Ministry of Finance and Economic Development.

Gezahegre Ayele, Ethiopian Agricultural Research Organization (EARO).

Chris Barrett, Cornell University.

Samuel Benin, International Livestock Research Institute (ILRI).

Montague Demment, Director, Global Livestock CRSP.

Godana J. Doyo, Arid Lands Resource Management Program (ALRMP).

Ayele Gebre-Mariam, Africa Consult.

Getachew Gebru, Utah State University.

Ali Mohammed Gedi, Red Sea Livestock Trade Commission.

David Hadrill, FAO Project Manager, DireDawa.

Guyo O. Haro, Global Environmental Facility (GEF)/German Agency for Technical Cooperation (GTZ-IS).

Mary Hobbs, USAID/Regional Economic Development Services Office (REDSO).

Aliye Hussen, DG, Oromia Agric-Research Institute.

Belachew Hurrissa, Livestock Marketing Authority (LMA).

Mohammad Jabbar, International Livestock Research Institute (ILRI).
Abdullahi Dima Jillo, Egerton University.
Robert Kaitho, Texas A&M University.
Stephen Kariuki, Pastoralist Integrated Support Program (PISP).
David Kinyua, REDSO/Food Security.
Charles Lesingiran, Food for the Hungry International.
Peter Little, University of Kentucky.
John McPeak, Syracuse University.
Ali Hassan Mohamed, FARM-Africa.
John Morton, University of Greenwich.
Diana Putman, USAID/REDSO.
Maren Radeny, International Livestock Research Institute (ILRI).
Mulugeta Shibru, CARE-Ethiopia.
Jerry W. Stuth, Texas A&M University.
Chachu Tadicha, Community Initiatives Facilitation Assistance (CIFA).
Alemu Wosenyeleh, ELFORA Agro Industries.
Fred Zaal, Amsterdam Institute for Global Isues and Development Studies (AGIDS)–University of Amsterdam.

Collaborating Institutions

This short-term project was led by John McPeak at Syracuse University and there were no formal collaborating institutions.

Publications

No journal or book chapter publications were completed in the past year on this project. The two outputs of the project were the annotated bibliography distributed at the Nairobi meeting, and the workshop proceedings that have been electronically distributed to workshop participants. The annotated bibliography is available at: http://glcrsp.ucdavis.edu.

Principal Investigator

Lead Principal Investigator. Dr. John McPeak, Dept. of Public Administration, Maxwell School, Syracuse University, Syracuse, NY 3244. Phone: 315-443-6146; Fax: 315-443-9721; Email: jomcpeak@maxwell.syr.edu.

Managing National Parks in the Context of Changing Human Populations and Economics: Strengthening Collaboration Between Researchers and Managers Working In and Around Serengeti and Yellowstone National Parks

Narrative Summary

The SEYE project is comprised of a set of discrete planning activities with the near-term goal of solidifying collaboration between researchers and managers associated with Yellowstone and Serengeti National Parks and their greater ecosystems. The planning activities include a workshop in Africa to bring U.S. and African researchers and managers together to define collaborative opportunities. These activities will lay the foundation for the future of the project, aimed at creating a more formal ongoing collaboration on shared issues of management, training, and research. The long-term goal is to contribute to the capacity necessary to maintain and sustain these natural areas as representatives of two of the world's premier national park systems and biodiversity preserves.

Research

Problem Model. Serengeti and Yellowstone are arguably two of the world's most significant national parks. As large nature reserves, they are similar in that they contain biologically diverse and largely intact grazing ecosystems surrounded by pastoralists and ranchers whose livelihoods are dependant on livestock. In various ways, they have both served as models for conservation in the context of competing human land uses in and adjacent to the parks.

Although the physical, biological, and socio-economic situations of the two parks are strikingly different (Berger 1991), profound functional similarities exist (Frank et al. 1998). Both systems are large and heterogeneous with strong topographically controlled vegetation gradients that range from semi-arid grasslands to closed woodlands or forests. Large migratory grazers track the spatial and temporal variability in resources along these gradients. Both parks conserve only a portion of the ecosystems in which they reside and on whose resources the parks depend for their long-term sustainability. Agents of disturbance are similar, including fire, livestock grazing, and animal diseases. The dynamics of both systems are intimately tied to human activities, including hunting, grazing, recreation, and eco-tourism. Ecosystem simulation models developed for Yellowstone can be readily modified for extension to East African ecosystems (Coughenour and Singer 1996, Boone et al. 2002) and some such as POLEYC/SAVANNA (funded in part by GL-CRSP) have already been applied in both parks.

The research literature comparing the ecology of the two systems is rich, but there is no similarly comprehensive comparison of conservation management issues and strategies between Yellowstone and Serengeti National Parks, including the ecosystems and communities in which they are embedded.

The SEYE project is comparing and contrasting the ecological, socio-economic, and policy contexts for the Yellowstone and Serengeti National Parks as vehicles to conserve biodiversity and promote sustainable livelihoods. The comparison will address several critical management challenges that are shared by the two park systems, including:

- Human population is increasing along the boundaries of both parks;
- Population and land use change at the edges of the parks and reserves alter animal migrations in and out of reserves and their interaction with livestock;
- Disease transmission between livestock and wildlife alters the population dynamics of animals and constrains management practices for the parks, pastoralists, and ranchers in the ecosystem;
- Regional economic stability is tied to each park's amenity values in complex, and often disputed, ways;
- Effective management will address issues and processes that span jurisdictional boundaries, including lands and policies outside the parks.

Comparative analyses of Yellowstone and Serengeti will be useful in their own right and at the same time will contribute to a larger effort to link current theoretical advances in conservation biology, sustainability, and ecological resilience to practical issues of design and management (Barrett and Arcese 1995, Norton-Griffiths and Southey 1995, Gunderson et al. 1995, Ellis and Swift 1998, Brandon et al. 1998, Walker 2002).

Progress. Our progress was impeded by constraints on travel imposed by the political turmoil of 2003. Progress in the latter half of 2003 has been strong, including the following:

- First,a study tour was hosted for senior Tanzanian National Parks (TANAPA) staff in Yellowstone National Park (YNP) in June 2003.
- Second, Dr. Glenn Plumb (YNP) and Dr. Lisa Graumlich traveled to the Greater Serengeti/Mara in August 2003 to meet with stakeholders and discuss and identify issue and problem models that can form the foundation for long-term collaborations.
- Third, East African perspectives on park science and management were incorporated into the 7th Biennial Yellowstone Science Conference to be held in October 2003.

Through these activities, we are developing jointly defined objectives for future collaboration. The final step in defining the relevant problems and problem models will take place in late January or early February 2004 when we will host a scoping workshop at Serengeti National Park. We see such a workshop as the final step in defining needs and opportunities for a sustained, multi-year follow-on effort that would link U.S. land-grant university researchers and land managers with their counterparts in East Africa.

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Walker, B. 2002. Ecological resilience in grazed rangelands: a generic case study. In Gunderson, L.H. and L. Prichard, Jr. (eds.), Resilience and the behavior of large-scale systems. Island Press, Washington, D.C.

Gender

The project has made strong efforts to ensure that women are strongly represented in all project activities. Towards that end, we had several notable successes. One of the four senior TANAPA officials to visit YNP in June 2004 was female (Anna Grace Kyoma). In meetings in Kenya and Tanzania, we sought out female participants in our informal workshops. The extensive professional network of Dr. Robin Reid of ILRI facilitated our contact with senior female researchers and managers.

Policy

In November 2003, we hosted two Tanzanian policy makers at the Big Sky Institute and Yellowstone National Park to brief them on the project objectives and to discuss policy implications. The visitors were: Mrs. M. Watondoha, Trustee of TANAPA and Member of Parliament, Dr. H. Mwakyembe, Trustee of TANAPA and member of the East African Legislative Assembly. Mrs. Watondoha invited Dr. Graumlich and colleagues to brief Parliament on project results in 2004.

Outreach

Given the preliminary nature of our project, we have not accomplished any specific outreach activities. We intend to target national park managers and land resource decision makers at the regional level in the U.S., Kenya, and Tanzania with our future efforts.

Developmental Impact

Environmental Impact and Relevance. Our project will contribute to developing a stronger scientific base for the management of Yellowstone and Serengeti National Parks and the lands surrounding these parks.

Agricultural Sustainability. Our project will enhance our understanding of disease transmission between livestock and

wildlife in and around Yellowstone and Serengeti National Parks.

Contributions to U.S. Agriculture. Our project will increase our understanding of the ecological interactions between national park and the lands surrounding these parks.

Contributions to Host Country. We anticipate that our project will contribute to the capacity of Kenya and Tanzania to manage the national park and reserve lands in such a way that promotes ecological integrity as well as the economic development of surrounding communities.

Linkages and Networking. We anticipate developing a strong network of U.S. and East African researchers and managers who have common interests and experiences in managing national park lands.

Other Contributions

Support for Free Markets and Broad-Based Economic Growth. We anticipate that this project will provide new perspectives on economic development, in particular, nature-based tourism in and around Yellowstone and Serengeti National Parks.

Contributions to and Compliance with Mission Objectives. We are in touch with the Kenyan and Tanzanian missions and are working to align our project with their objectives.

Concern for Individuals. Our concern for individuals is manifest in our plans to develop training opportunities for young and mid-career researchers and managers from the host countries.

Support for Democracy. We are not currently directly addressing support for democracy.

Humanitarian Assistance. We are not currently directly addressing humanitarian assistance.

Leveraged Funds and Linked Projects

National Science Foundation, Biocomplexity in the Environment, Global Change, Globalization, and the Vulnerability of Mountain Systems, 2001-2003, $80,000 (Graumlich, PI).

Collaborating Personnel

United States of America

Glenn Plumb, Supervisory Wildlife Biologist, Yellowstone National Park.

Kurt Alt, Research Biologist, Montana Fish, Wildlife & Parks.

Andrew Hansen, Department of Ecology, Montana State University.

Michael Coughenour, Natural Resource Ecology Lab, Colorado State University.

Kenya

Dr. Robin Reid, International Livestock Research Institute, Nairobi.

Samson Lenjirr, Chief Warden, Masai Mara Game Reserve.

Ole Kamauro, International Livestock Research Institute, Nairobi.

Tanzania

Dr. Charles Mlingwa, Director General, Tanzania Wildlife Research Institute.

Dr. Emmanuel J. Gereta, Principal Ecologist, Tanzania National Parks.

Allan Kijazi, Acting Director General, Tanzania National Parks.

Collaborating Institutions

United States of America

Montana State University
Big Sky Institute
106 AJM Johnson Hall
Bozeman, MT 59717

Kenya

International Livestock Research Institute
Phone: 254-020-630749
Fax: 254-020-631499

Masai Mara National Reserve
Phone: 254-305-22241

Tanzania

Tanzania Wildlife Research Institute
Phone: 255-27-277-677
Fax: 255-27-254-8240

Tanzania National Parks
Phone: 255-27-250-1930
Fax: 255-27-250-8216

Principal Investigator

Lead Principal Investigator. Lisa J. Graumlich, Big Sky Institute, Montana State University, Bozeman MT, 59717. Tel: 406-994-5320; Fax: 406-994-5122; Email: lisa@montana.edu.

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

Narrative Summary

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

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

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

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

Research

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

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

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

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

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

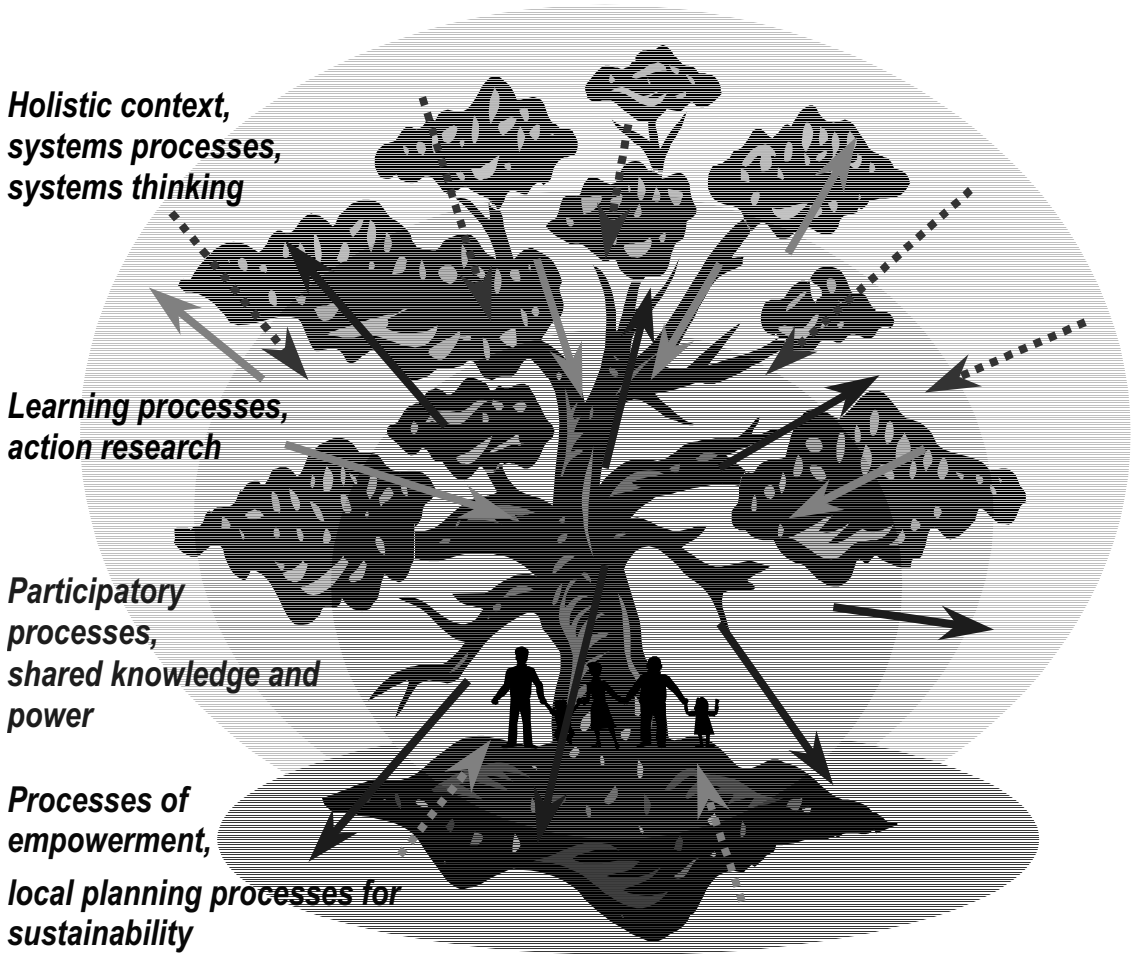
Activity One: Creating a Process of Community-Based Participatory Agricultural Development

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

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

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

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



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

selection, application, and interaction of these four processes.

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

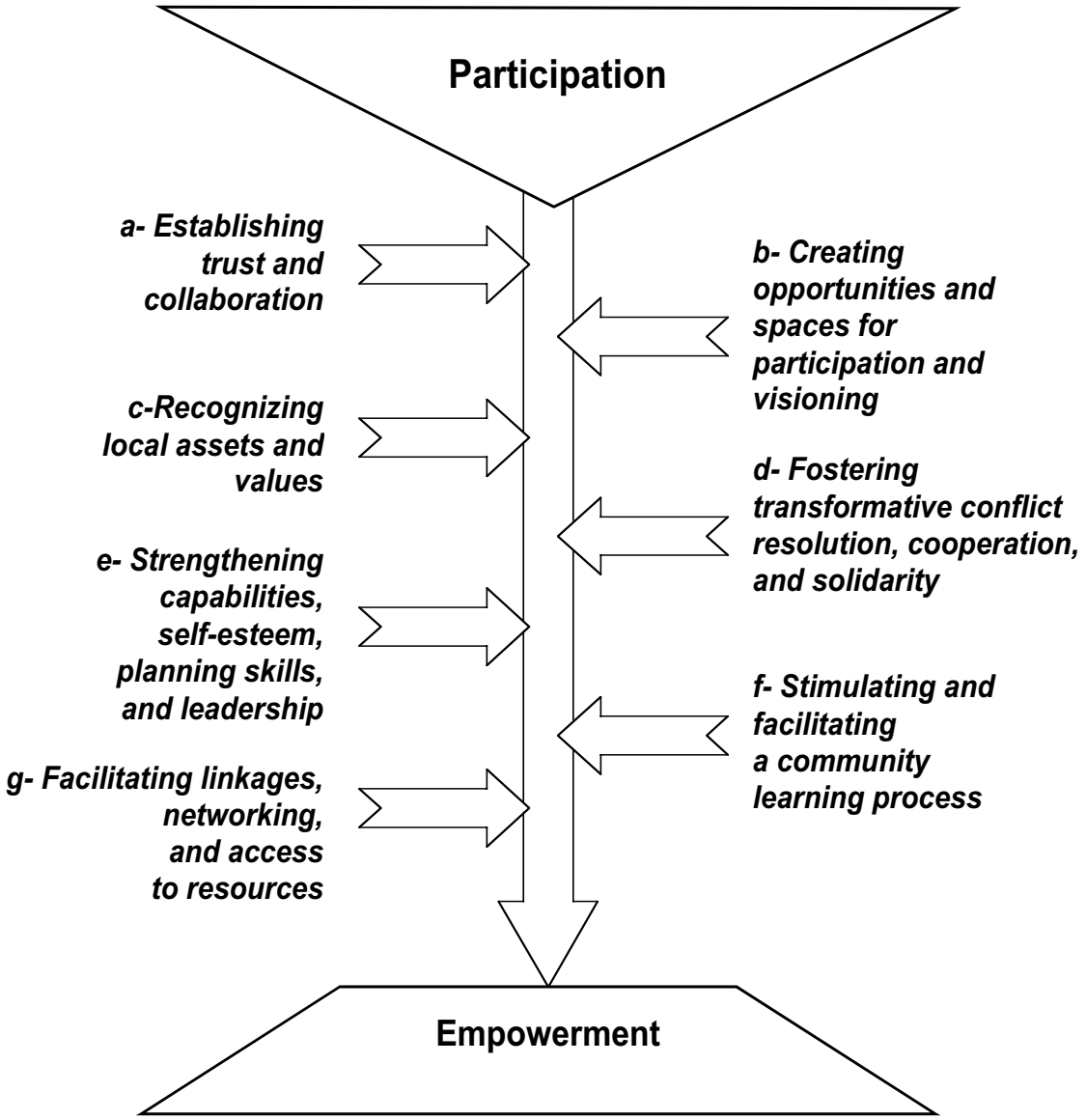
Systems thinking stresses the inter-related, interconnectedness of everything and focuses on linkages and processes -- how things are interconnected, the processes that connect them, and the processes and the dynamics of systems. It means seeing systems as complex networks of causes and effects with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

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

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

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

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



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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

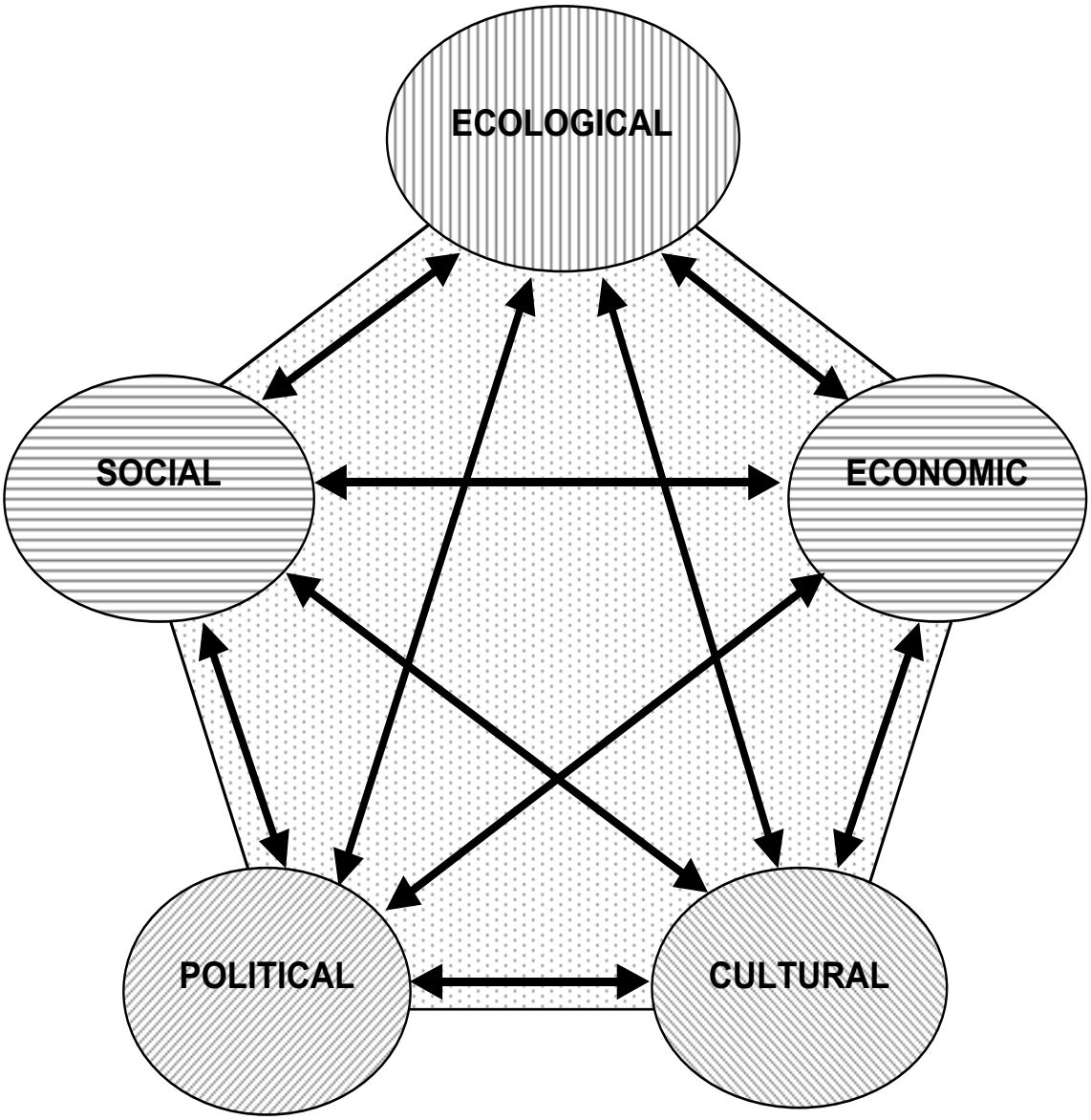
Objective 1.5: Development of a plan for the publication and dissemination (in Spanish and English) of PLAN products: educational materials and scientific results.

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

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

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

Figure 3 - PLAN pentagon of sustainability.



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

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

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

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

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

Objective 2.3: Promotion of restoration of watershed protection forests.

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

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

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

Activity Three: Understanding the Dynamics of Extensive Livestock Production

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

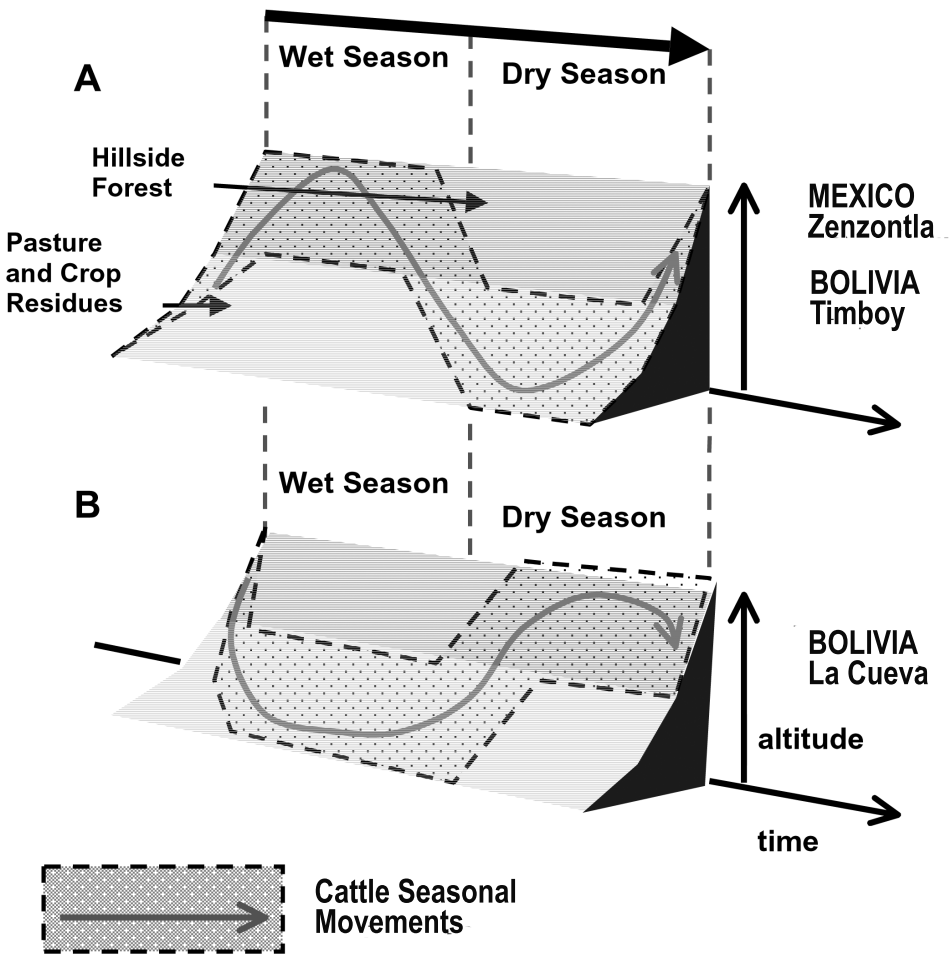
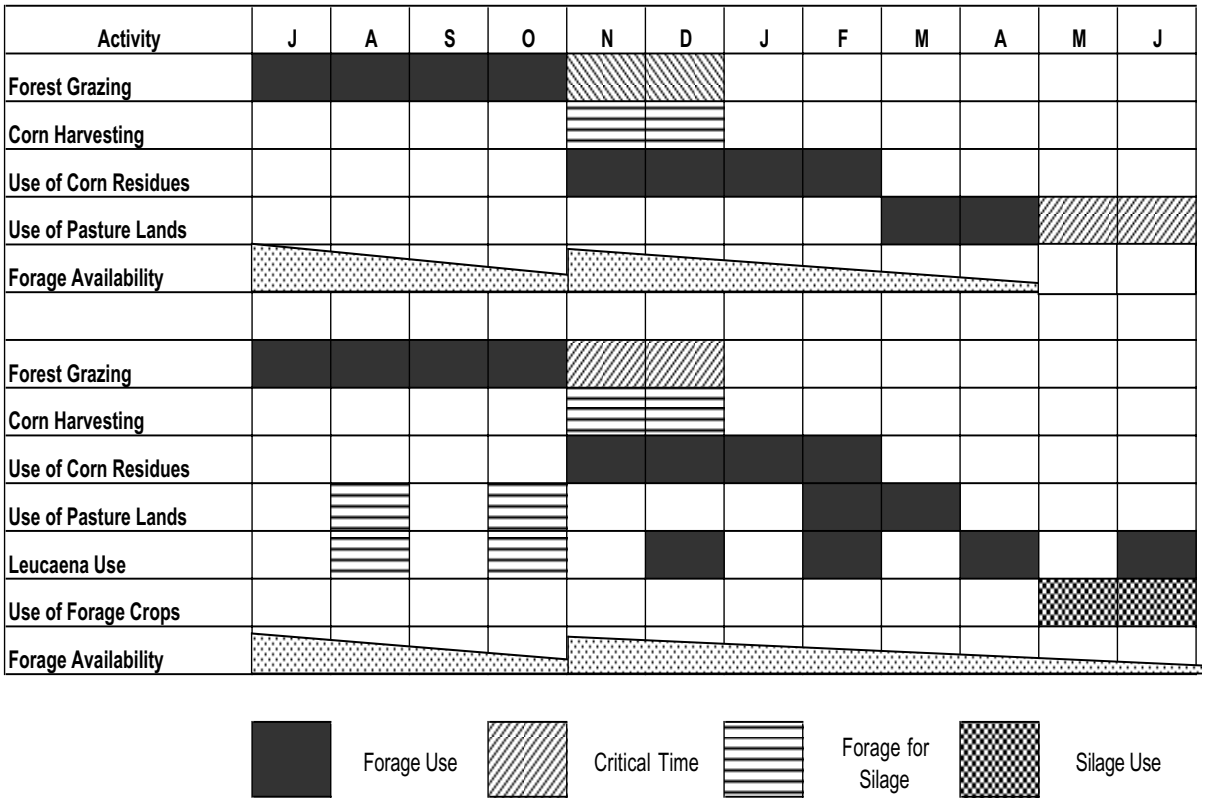


Figure 5 - Current forage management (above) and proposed forage management (below).



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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Objective 5.4: Experimentation with improved crop production systems. Activities to increase the production of cultivated crops through practices to rehabilitate degraded systems. Design and implementation for the introduction of non-native, herbaceous legumes to enable maize production on degraded soils in abandoned fields (E).

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Objective 7.1: Validation of a food security instrument.

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

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

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

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

Objective 7.2: Farmer experimentation projects.

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

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

in rural development as a way to generate new forms of participatory investigation.

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

Objective 7.3: Home gardens and irrigation in Mexico.

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

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

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

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

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

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

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

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

[1] *Points in a food security scale (0-18).*
[2] *Based on 8 children's items. Maximum score: 8 points.*

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Activity Nine: Strengthening Community Organizations and Local Planning Processes

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Gender

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

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

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

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

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

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

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

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

Policy

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

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

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

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

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

Outreach

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

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

Developmental Impact

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

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

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

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

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

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

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

Other Contributions

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

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

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

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

Leveraged Funds and Linked Projects

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

United States of America

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

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

Bolivia

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

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

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

Ecuador

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

Mexico

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

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

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

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

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

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

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

Training

In Progress

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Completed

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

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

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

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

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

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

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

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

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

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

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

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

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

Non-degree Training

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

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

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

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

Collaborating Personnel

United States of America

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

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

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

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

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

Milofsky, Tessa, Graduate Student, UW - Madison.

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

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

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

Sansom, April, Graduate Student, UW - Madison.

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

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

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

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

Bolivia

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

Calla, Rhinda, Sociology, JAINA.

Cari, Christina, Agronomy, CER-DET.

Carranza, Freddy, Agronomy, JAINA.

Del Carpio, Ricardo, Agronomy and Business, JAINA.

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

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

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

Espinoza, Linder, Researcher, Forestry, AGROSIG.

Flores, Magaly, Agronomy, Biology, JAINA.

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

Gallardo, Norberto, Lawyer, CER-DET.

Juardo, Monica, Student, AGROSIG.

Lizárraga, Pilar, Researcher, Sociology, JAINA.

Lozano, Angelo, Agronomy, CER-DET.

Mealla, Grover, Agronomy, CER-DET.

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

Molina, Jesus, Agronomy, JAINA.

Montaño, Blanca, Sociology, CER-DET.

Mujica, Roberto, Agronomy, Ecology, AGROSIG.

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

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

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

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

Ecuador

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

Mexico

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

Collaborating Institutions

United States of America

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

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

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

Bolivia

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

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

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

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

Ecuador

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

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

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

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

Mexico

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

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

Principal Investigator

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

Livestock Development and Rangeland Conservation Tools for Central Asia

Narrative Summary

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. The sustainability of extensive production and human nutritional welfare was 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 1990s 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. The rangelands of Central Asia 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. This project addresses the immediate need to improve the welfare of small landowners, to prevent further deterioration of rangelands, and to document their role as carbon sinks.

We take an integrated multi-disciplinary approach to improve the welfare of herders, involving not only on-farm solutions for 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 activities proposed for 2002-2003 were directly linked to the original problem model with minor modifications. Geographic information systems (GIS) and continuous monitoring of carbon dioxide (CO_2) fluxes are the core components, supplemented by animal production and socio-economic modules.

Accomplishments for this year were significant because they brought us very close to the original goal of integration across modules. Carbon flux measurements were integrated with the United States Department of Agriculture-Agricultural Research Service (USDA-ARS) AgriFlux network, yielding better models and more precise predictions for both United States and Central Asian rangelands. We produced maps of estimated carbon flux over extensive areas of Central Asia, and provided policymakers with a clear roadmap to position the region in the carbon credit market. Rangeland forages were characterized nutritionally and the information was disseminated in publications. A biologically detailed model of sheep

production was integrated with an economic model, yielding support to the hypothesis that livestock production in Kazakhstan is severely limited by availability of credit to smallholders. Small investments on supplementation and forages for the winter should result in sizable returns. This trend of practical results is accelerating and is expected to have full impact one or two years after the end of the project, as the information finally reaches dissemination outlets.

A summary of accomplishments for the 2002-2003 year follows by research activity. The planned activities were accomplished with slight departures from the original plans. Some activities had to be cancelled due to reduced funding.

Research

Activity One: GIS and Basic Resources Module

Problem Statement and Approach. 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 Kazakhstan, Uzbekistan, and Turkmenistan. Information is used for direct dissemination and as a basis for the other modules and components. During the sixth year of the project we have augmented the regional GIS in Uzbekistan, created and distributed a spatial tool for Central Asia (ACT A-Where), and established regional estimates of carbon balance in rangelands by integrating the GIS and CO_2 flux modules.

Augmentation and refinement of the databases emphasize the integration of meteorological and remote sensing data. Integration of project components was done to build, synthesize, and calibrate spatial models, validate these models against ground truth and Moderate Resolution Imaging Spectroradiometer (MODIS) 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 grasslands and then integrated in the GIS over the spatial extent of the region to produce landscape-level estimates of total carbon flux.

Progress. Ecoregional estimates of carbon (C) balance in rangelands were established for the growing seasons using CO_2 flux and remote sensing data from three study sites. The goal of mapping 1998–2001 carbon fluxes in Central Asia has been delayed as USDA-ARS AgriFlux data sets are utilized to strengthen Central Asian predictions and partition net ecosystem CO_2 exchange (NEE) into gross primary production (GPP) and ecosystem respiration (Re) components. GPP algorithms have been developed and Re and NEE algorithms will be developed using northern Great Plains flux towers. Quantification and mapping of seasonal dynamics of NEE, GPP, and Re have been published for the year 2000 growing season in the Journal of Environmental Management.

Satellite imagery, meteorological data, and Bowen ratio-energy balance (BREB) data at CO_2 flux sites in Kazakhstan and Uzbekistan have been collected, along with a long-term study from the western United States. Together with the CO_2 component, grassland models were parameterized based on these data. Quantification and mapping of Kazak steppe seasonal fluctuations of CO_2 have been published in the Journal of Environmental Management.

Generation of GPP and Re from Turkmenistan and Uzbekistan was given low priority due to low CO_2 fluxes and poor sunlight-CO_2 flux response curves at these sites. However, 2001 Uzbekistan fluxes were

processed into GPP and Re components and agreed fairly well with normalized difference vegetation index (NDVI) early in the spring, but later season fluxes may indicate abiotic (e.g., inorganic soil physico-chemical) processes that may absorb atmospheric CO_2 during the hot, dry summer.

Additionally, satellite data (NDVI) and meteorological data (precipitation, temperature) at non-BREB sites were collected from Kazakhstan and Uzbekistan along with AmeriFlux sites in the western United States. Analysis of Kazakh biomass data indicates location and/or footprint problems and thus was not used.

Spatial data sets (NDVI, elevation, ecoregion) have been prepared in a manner consistent with the U.S. data sets. This includes the temporally smoothed NDVI data sets 1998–2001 and NDVI metrics. Exceptions are the photosynthetically active radiation (PAR) data sets, which are only produced for North America (http://www.atmos.umd.edu/~srb/gcip/), and the U.S. STATSGO soils data sets. Regression tree analysis indicated minor use of the soil moisture anomaly maps for the Re algorithm in the northern Great Plains. We are procuring full field soil moisture data sets for further testing.

Algorithm development for the mapping of winter fluxes that would allow closure of annual carbon budgets has been problematic. The winter fluxes from Shortandy, Kazakhstan were pooled with winter flux values from Mandan, North Dakota and Miles City, Montana. The regression tree algorithm accounted for 72% of the variation observed in winter fluxes. However, the model used the site variable to group Miles City and Mandan fluxes separately from the Shortandy winter fluxes. One possible explanation for this is that the Shortandy fluxes were measured with an eddy covariance system, which had been recently discovered to have a timing error in the measurements of densities of CO_2 and water vapor. This error was confirmed to underestimate CO_2 fluxes with the eddy covariance system. This is apparently significant for winter fluxes when magnitudes of CO_2 fluxes are small. Until these issues are resolved, scaling of winter fluxes would not be warranted.

Based on data of aboveground biomass collected throughout the 2002 growing season, the potential carbon assimilation of the different agroecosystem types was analyzed. The data was collected in all four ecosystem types (wheat, abandoned land, virgin land, and crested wheatgrass) from the four blocks used for the CO_2 flux experiment. For this analysis, the three samples taken at every field each time were averaged and the highest value of the season was taken as the potential biomass production for each ecosystem (N=4 for wheat and abandoned land; N=3 for virgin land and crested wheatgrass). Wheat and abandoned land are the ecosystem types that assimilate the highest amount of biomass in one year (both 4.6 t ha^{-1}), compared to crested wheatgrass (3.0 t ha^{-1}) and virgin land (2.2 t ha^{-1}). The variability of these estimates, measured through the coefficient of variation (CV), shows that wheat and virgin land have very stable productions throughout the landscape (CV= 15%), whereas the abandoned lands are much more variable (CV=55%). Crested wheatgrass was found to be at an intermediate level of variability (CV=34%). Further calculations are needed to estimate the real carbon assimilation because two of these ecosystems (wheat and crested wheatgrass) export a big percentage of their biomass production as grain and forage, respectively, and part of the biomass from the previous year is lost via decomposition and/or respiration.

From these data it seems that the abandoned lands have the highest potential to capture CO_2 from the atmosphere in northern Kazakhstan.

The Country Almanac (Almanac Characterization Tool or ACT) was completed for Kazakhstan. The ACT is an integrated spatial information system designed for agriculture and natural resource management. The ACT's analytical and visualization tools enable the rapid characterization of areas within the target geographic regions.

The ACT software for Turkmenistan and Uzbekistan (completed Summer 2002) was complemented by the construction of a foundation database for Kazakhstan in the fall of 2002 by the Central Asian Regional Environmental Center (CAREC) and currently includes climate, meteorological, infra-structural, demographic, topographic, and political data. CAREC has developed an Ecological GIS for all of Central Asia based on the ACT Software. CAREC plans to include existing information in the ACT software for Tajikistan and Kyrgyzstan as well.

The software was distributed to government and non-governmental agencies in Kazakhstan, Turkmenistan, and Uzbekistan through a workshop held together with CAREC. Participants received a copy of the software, licenses for the software, and the ACT manual (Russian translation) upon completion of the workshop. Since the workshop, CAREC has continued to distribute the software. CAREC reported that many agencies expressed interest in the software but preferred to receive additional training in addition to just the software. Questions to CAREC on use of the software continue and the English-only platform has presented problems to the users.

The Uzbekistan GIS data set has continued to grow with extensive work on the creation of vegetation and soil maps. The vegetation map was completed along with a soils map (scale 1:2500000) using CartaLinks software. Maps were created in the Gaus-Kruger projection. The Uzbek GIS team organized a GIS seminar for faculty and students of the Biology and Ecology Departments at Samarkand State University. Presentations included: 1) general directions of GIS; 2) methods of using GIS and its potential; 3) methods of processing and analyzing data using GIS tools; and 4) using A WHERE-ACT software for studies of desert ecosystems and rangelands. Twenty-nine faculty and students attended. In addition, lessons and seminars on GIS methods were taught at the Academy of Sciences for postgraduate students and students in the bachelors and masters programs of the Department of Ecology of Desert Pastures.

Activity Two: Range Forage and Carbon Flux Module

Problem Statement and Approach. 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, providing opportunities to trade "carbon credits." Daily and seasonal carbon balances of rangeland ecosystems are measured with a Bowen ratio-energy balance (BREB) technique that calculates net ecosystem CO_2 exchange (NEE) between a terrestrial surface (including soil and vegetation) and the atmosphere. The NEE was monitored continuously during the 2003 growing season in the following study sites in Central Asia (described in the GL-CRSP annual report for 2001).

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. Fluxes of energy, water vapor, and CO_2 may differ within rangeland ecosystems and among types of land. To assess the spatial variability of fluxes across a landscape, two state-of-the-art eddy covariance (EC) systems were deployed for continuous measurements of fluxes in two rangeland ecosystems: abandoned cropland and crested wheatgrass hayland. This is a follow-up data collection in conjunction with the roving EC measurements that were done during the 2001-02 growing seasons. The study sites were located within the research experiment station of the Barayev Kazakh Research Institute for Grain Farming near the town of Shortandy in northern Kazakhstan. Data processing and analyses are ongoing for the roving EC measurements obtained during the 2001-02 growing seasons.

A timing error was recently discovered in the flux measurements from the open path infrared gas analyzer (IRGA) (model LI-7500, Li-Cor Inc.) being used with the EC systems. The main effect of this timing error is an underestimation of water vapor and CO_2 fluxes. Fluxes from EC measurements obtained in 2001-02 are being recalculated using time series (10 Hz) data. A program has been written to maximize the eddy covariances using the 10 Hz data sets. Additionally, recent developments for correcting EC fluxes (e.g., coordinate rotation, frequency response, and Webb, Pearman, Leuning equation corrections) are incorporated to the quality assurance protocols for EC data. Pre-existing flux processing programs have been re-coded for computer programs PC-SAS and MATLAB.

The BREB measurements were continued for the 2003 growing season at two rangeland sites: sagebrush-ephemeroid semidesert at Karnap, Uzbekistan, and shrub sandy desert at Karrykul, Turkmenistan. Data at 20-minute intervals have been received at Utah State University where data processing and quality assurance will be performed.

A mathematical model has been developed for predicting energy, water vapor, and CO_2 fluxes. This model is based on basic principles of thermodynamics and biophysics of carbon fixation and respiration. The model was developed from an extensive literature survey and discussions with experts in carbon flux research. A novel method of extracting ecosystem-specific parameters has been incorporated into the model. This model has been parameterized with data collected from a pristine grassland that represents the Kazakh steppe ecoregion. We will use this model as a tool for estimating and interpreting the dynamics and magnitudes of CO_2 fluxes in the Kazakh steppe.

The CO_2 scaling up project has integrated the flux tower measurements from the USDA-ARS AgriFlux network and this project (LDRCT) in Central Asia. Temporal and spatial scaling up of flux tower measurements to ecoregion levels is achieved through the use of modeling, remote sensing, and GIS techniques. NEE was partitioned into fluxes associated with gross primary productivity (GPP) and ecosystem respiration (Re) as demonstrated in the Kazakh steppe ecoregion. GPP and Re were mapped from May to October 2000. Maps of regional fluxes were developed for a whole growing season and included the 10-day temporal dynamics that were generated from normalized difference vegetation index (NDVI). A predictive algorithm to estimate GPP from NDVI and other spatial/temporal GIS data sets ($R^2 = 0.92$) was developed from North American flux tower sites in Texas to southern Canada. This algorithm was tested using the flux tower data from Shortandy, KZ (1998-2000) and found to have good agreement ($R^2 = 0.63$) between observed versus predicted GPP. This indicated that carbon fluxes at the Shortandy site were similar to the rangeland sites in the United States, thus flux tower data will be pooled to develop a more robust algorithm.

A web page has been created to showcase the scaling up project through South Dakota State University (SDSU) and the United States Geological Survey Earth Resources Observation Systems (USGS EROS) Data Center (http://edc.usgs.gov/carbon_ cycle/). This web page supplements the original web page (http://edcintl.cr. usgs.gov/carboninfo sheetca.html). It provides a chronological presentation of SDSU and EROS research including publications, an interactive presentation of GPP and Re maps of the Kazakh Steppe, and links to the USDA-ARS AgriFlux and GL-CRSP project on scaling up of carbon fluxes.

A brochure entitled "The potential of Carbon Credits," specific to Kazakhstan, was published and distributed to U.S. and Kazak agencies. The brochure is based on data from the LDRCT project and other studies in the U.S. and Central Asia that have shown that the rangelands of Central Asia are sequestering carbon at a significant rate. Based on this data, carbon credits and policies to promote sustainable use of rangelands are valid options for the Kazak government. The brochure contains tangible examples and a basic road map for leaders to make carbon credits a reality for Central Asia. It is likely that the market of carbon credits will reach a point of exponential growth, and early positioning will have substantial payoffs.

Activity Three: Animal Production Module

Problem Statement and Approach. 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; and (2) create modern planning capabilities in the host countries by establishing laboratories, providing training to host country scientists, and developing computer-based maps of production and development potential.

Activities are comprised of research on the diet composition of sheep, determination of the nutritional quality of the range and its dynamics throughout the forage year, development of GIS map layers for soil types, range type, range primary production (availability and quality) and range secondary productivity (potential animal performance levels for specified management systems), and the application of a bio-economic simulation model of small ruminant production systems. 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 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. The animal production module made important progress during the 2002-03 year. Monitoring of range condition and trends on all major range sites in Uzbekistan was completed this year. In June of 2001 the first season of fieldwork was conducted. On three field expeditions, six sites for monitoring of range condition were set up, and extensive vegetation surveys were conducted. These sites are: Karnap, Bukhara (two sites), Kultshuktau (Kyzelkum desert), Tamditau (Kyzelkum), and Nurata Mountain Sheep Reserve. All sites are visited three times per year. On all sites, the vegetation is surveyed for cover, density, species composition, biomass, and brush utilization. Samples of range plants are collected for laboratory analysis of nutritional properties. The last survey in the project was conducted in October of 2003; therefore, there are now two years of range monitoring data available. These data are currently in analysis for publication in scientific journals.

Data from previous studies conducted in Soviet times in Uzbekistan were computerized. A database containing four years of range inventory (condition data) from the Karnap site was computerized and the results of the analyses reported at the International Rangeland Congress.

The determination of the diets of sheep and goats on the Uzbek range made important progress this year. Trials to determine the diet composition of sheep and goats on rangelands, using the alkane marker method with controlled-release devices, began on one site. Comprehensive sets of species from the Kazakh steppe were characterized for ruminant nutrition. Results were published in the proceedings of the International Rangeland Congress.

Only three animal experiments were conducted, however, because import restrictions for animal samples increased the cost of these experiments beyond the limit of the project budget. The samples collected for determination of intake and digestibility are currently assayed in a collaborating laboratory in Israel (Newe Ya'ar Research Center, ARO, Israel).

All forage samples for the determination of nutritional quality of Uzbek range plants have been prepared for analysis and catalogued. They are currently in Samarkand. An attempt to import whole plant specimens was unsuccessful, as the Animal and Plant Health Inspection Service (APHIS) detected spores of a listed fungus on some samples. Destruction of two years' worth of fieldwork was narrowly avoided. A Wiley mill for on-site sample preparation was purchased and shipped to Uzbekistan. Because of a clerical error, it took almost six months to release the mill from customs and begin processing in Samarkand. Samples are scheduled to arrive in the Davis lab in November.

All GIS layers except those for primary and secondary range productivity are completed and ready for release. The missing layers depend on the pending completion of Activities Three and Four.

The planned work in Turkmenistan had to be cancelled, however, due to the reduction in available funding. Part of the planned investments into laboratory facilities in Uzbekistan will also not be possible.

Activity Four: Socio-Economic Module

Problem Statement and Approach. The goal of the socio-economic (SE) module is to provide a set of policy recommendations for the future development of livestock production in Kazakhstan that are consistent with the new market system and resource endowment. To achieve this goal, our analyses focused on the following two aspects. First, we analyzed the behavior of the Kazakhstan livestock sector during the last decade of transition (from a central planning to a market economy) to understand the current situation for livestock producers. Using published statistics and reports and information from field interviews in 1999 and 2001, we seek to explain why the livestock sector followed the observed transition path, which was characterized by a sharp decline in the livestock population and output and a change in the dominant farm types (from collective entities to subsistence units).

The second part of our analysis derives policy implications from a livestock production model. From the results of the first part of the analysis, we chose to model extensive livestock production by family farms, which we hypothesize have the potential to significantly increase output. A stochastic dynamic programming (SDP) model was developed for a sheep producer in southeastern region of Kazakhstan. The model is used to analyze optimal management, given model parameters, and to evaluate policy alternatives.

Progress. We completed the first part of the analysis and explained how Kazakhstan's livestock population and production declined dramatically since 1991 with the transition from a centrally planned to a market economy. As a result of market liberalization, input prices rose and output prices fell, sharply reducing the profitability of livestock production. The price effect was exacerbated by a government decision to tax the livestock sector implicitly by requiring producers to sell meat to state purchasing agencies at lower than market prices. A poorly designed and implemented farm privatization program, combined with the collapse of the Kazakhstan capital market, caused massive liquidation of livestock capital. Large farms sold nearly all their livestock. Rural households received many of these animals, but could not profitably maintain most of them. Although nearly all livestock are now on small farms, government livestock planning and policies often still seem focused for large farms with a capital-intensive structure. Commonly observed rangeland

institutions also encourage livestock holding by subsistence rural households that probably cannot become viable commercial producers. Although this form of livestock holding had an important role during transition, policies for future development of the sector should promote the emergence of commercial producers and efficient rangeland management.

We successfully completed parameterizing the bio-economic SDP model. The model involves a maximization of expected net present value of profit stream from a sheep enterprise given forage, sheep biology, and economic parameters. Since producers do not know the future levels of forage production at the time that decisions are made, the decision problem has a stochastic nature. The specifications of forage production and sheep biology were derived from a sheep simulation model developed by E.A. Laca. Economic parameters (output prices and costs of production) were obtained from published statistics, farm surveys, and monitoring activity conducted during this project.

Preliminary results of the model exercises suggest the following. First, in a series of model runs with different constraints on feed availability, we found that feed supplementation during the grazing season has the potential to significantly increase producer welfare. Without supplementation, the simulated flock size fluctuates significantly in response to fluctuations in forage production and, when a more nutritious alternative (barley in our model) to grass hay is not available during the winter feeding period, the sheep production system is not sustainable. Supplementation, by mitigating the shocks of poor forage production on animal productivity, allows maintenance of production at a high level. We estimate that making one ton of hay available during the grazing season would increase the capital value of the flock by up to $700. The estimated cost of producing such hay is much less.

The optimal feeding strategies suggested by the model do not resemble the current practices observed on family farms in Kazakhstan. Typically, feeding in our study area consists of grass hay during the winter at a low level and no supplementation during the grazing season, whereas the model suggests that feed supplementation should be profitable. We hypothesize that family farms face difficulty in financing a higher level of feeding. A capital constraint limits the scope and the level of feeding during the winter and regular grazing seasons. When the model is altered to include a capital constraint, the model produces a feeding regime much similar to that currently observed. According to our preliminary estimates, if the capital to finance feeding of a flock of 1,368 sheep is limited to $1,000, relaxing the capital constraint by $1 would increase the capital value of the flock by $6 to $17, depending on forage production levels.

Our preliminary results suggest that the currently observed practices of sheep production by family farms are consistently explained by a lack of working capital to finance winter and supplementary feed, including haymaking and conservation. The state's livestock policies currently seem to focus on the introduction of purebred animals. Unless the new breeds introduced are suitable for use under severe feeding conditions, the animals will likely face a feed limitation. The appropriate direction of intervention may be to assist in the development of lending institutions for small farms. Haymaking and conservation for its use as a supplement during the grazing season should be encouraged. Assistance in the development of efficient feed markets may also be appropriate.

Dissemination of results. Host country scientists were briefed and consulted on the progress and plans of the project. Host country scientists also presented results of the LDRCT project at national meetings in their respective countries.

Several scientific articles were produced detailing results on CO_2 sequestration and animal production and rangelands in Central Asia. Research Briefs were produced as well in this reporting period, and project participants attended several conferences where they presented posters. These publications are available through regular library services and through the Internet.

The ACT A-Where software was distributed to several governmental and non-governmental agencies in Central Asia, including the ministries of ecology from the five Central Asian states, the Geography Departments at Kazak National University and Almaty State University, the Institute of Space Research in Kazakhstan and Uzbekistan, United Nations Development Program (UNDP) Kazakhstan, Uzbekistan and Kyrgyzstan, the Organization for Security and Cooperation in Europe (OSCE) office in Kazakhstan, Committees on Land Resources of Kazakhstan and Uzbekistan, Hydrology and Meteorology Departments of Kazakhstan and Uzbekistan, Global Mechanism of the International Fund for Agricultural Development, German Development Agency (GTZ), and the Kazak State Institute of Science and Technology.

The software has also been presented at international meetings by the Central Asian Regional Environmental Center (CAREC), including the Committee on the Challenges of the Modern Society (CCMS) Working Group Meeting (Nov. 19-21, 2002), the Asia Pacific Environmental Innovation Strategy (APEIS) Workshop on Integrated Environmental Monitoring of Asia-Pacific Region (Sept. 20-21, 2003) in Beijing China, "Current Livestock And Environment Interactions In The Commonwealth Of Independent States And Mongolia," held in the Kyrgyz Republic (May 4-7, 2003), and the Sub-Global Scenarios Workshop of the Millennium Ecosystem Assessment in Penang, Malaysia (March 4, 2003).

The project's brochure entitled "The Potential of Carbon Credits" was distributed to U.S. and Kazak agencies and advertised through leading electronic bulletins in Central Asia. This brochure is designed for policymakers and government officials involved in carbon issues, as well as for those in industry who have an interest in preserving the rangelands of Central Asia while promoting their sustainable use. We hope that this brochure will stimulate discussion and development of instruments that assist Central Asia to move towards policies that support economic growth and sustainable use of natural resources.

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, Mamedova, Kernshakaya), as collaborating scientists (Karibayeva, Shabanova, Soyunova, Lebed, Gaziantz, Young), as graduate students (Kobayashi, Toderich, Shakirova, Dubovic), and as technical assistants (Zemcova).

Policy

Important linkages developed in the past and reported last year continued to operate. One of the aspects of our research that has attracted the most interest from policymakers 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 policymakers are just beginning to seriously consider agricultural ecosystems as potential sites for mitigation of climate change. We informed regional scientists and policymakers about these possibilities with the publication of a brochure, "Potential of Carbon Credits," and have obtained significant leveraged funding to create a regional network for carbon flux measurement and modeling.

The CO_2 flux module has had an impact on the USDA-ARS National Program for Global Change, and we have been collaborating with the National Program Leader. Further details can be found on the website http://www.ars.usda.gov/research/projects/projects.htm?ACCN_NO=405809.

Outreach

Outreach was directed at producers, regional students, and research institutions of the region. In continuation of the program partially funded by the International Fund for Agricultural Development-International Centre for Agricultural Research in the Dry Areas (IFAD-ICARDA) and the GL-CRSP, ten of the students from the Kazak Agrarian University supported under this project completed their undergraduate degrees and two doctoral candidates completed their graduate degrees.

Numerous young scientists and doctoral candidates associated with the Baraev Institute of Grain Farming, the Sheep Breeding Institute of Kazakhstan, the Karakul Sheep Institute of Uzbekistan, the Uzbek Academy of Sciences in Samarkand, and the Institute of Desert Flora and Fauna of Turkmenistan were supported and given research opportunities through the project.

The animal production module established a future collaboration with an international NGO operating in Uzbekistan to continue its activities. In addition, new collaboration agreements were established with government agencies.

Developmental Impact

The GIS tool and information distributed will support and facilitate decision-making and development policies. The integrated activities in the carbon-flux module will contribute significantly to the assessment of rangelands as globally important carbon reservoirs and active sequestration agents. Once this takes place, there will be a strong motivation for all projects that link development and positive global impacts to focus in more arid areas instead of northern and tropical forests.

The brochure on carbon credits further promotes the sustainable use of rangelands as a valid option for the Kazak government. It is designed for policymakers and government officials involved in carbon issues, as well as for those in industry who have an interest in preserving the rangelands of Central Asia while promoting their sustainable use. We hope that this brochure will stimulate discussion and development of instruments that will assist Central Asia to move towards policies that support economic growth and sustainable use of natural resources.

The animal production module will contribute to the long-term sustainable production of livestock in Central Asia. The project is producing data essential for an improved match between animal genotype and environmental resources in Central Asia. The planning and analysis tools that will be developed will assist policy makers in Central Asia to address the grave environmental problems of livestock production on Central Asian rangelands.

The socio-economic model provided a good starting point for modification of policies. Specifically, Kazak agricultural policies should promote financing for forage and feeds accessible to smallholders while promoting the rise of larger commercial units.

Linkages and Networking

With strong leadership from the Management Entity of the GL-CRSP, LDRCT organized a key linkage between the U.S. rangeland carbon flux network and the Central Asian network. The GL-CRSP provided additional funds that were matched by USDA to establish a highly synergistic integration. The U.S. network is benefiting from this integration by receiving the techniques to produce maps of predicted annual carbon sequestration developed by LDRCT. LDRCT benefits by the access to a much larger and general database to develop more robust coefficients to produce spatial extrapolations in Central Asia.

For example, flux data (17 site-years or more) from the ARS AgriFlux network has been shared with LDRCT researchers at SDSU and USGS EROS. Utah State University has filled in missing meteorological data using relationships to other tower data. These parameters are needed for gap-filling of flux data and estimation of respiration and GPP components of NEE. Central Asia and USDA ARS AgriFlux data sets were used to assess the reliability of mapped precipitation, temperature, and PAR products obtained from the National Oceanographic and Atmospheric Administration (NOAA) Climate Prediction Center and GREWEX SRB. With this information, models were developed for the northern Great Plains grasslands and tested using flux data from Kazakhstan. The pooling of the datasets will allow a more robust mapping of the northern grasslands GPP flux in both regions and potentially similar eco-regions in the northern hemisphere. Additional sharing of Landsat TM imagery is enabling localized efforts to scale up fluxes.

A NASA interdisciplinary proposal was prepared by USGS EROS that included ARS AgriFlux and Central Asia flux participants, as well as university involvement. Funding for this proposal was unfortunately not awarded and funding is still being sought.

The LDRCT project participated in initial discussions of the Livestock Environment and Development Initiative (LEAD). LDRCT members from each participating country were proposed as members and have become active in the online discussions and meetings. The work of the initiative targets the protection and enhancement of natural resources as affected by livestock production while alleviating poverty (http://www.lead.virtualcentre.org/en/frame.htm).

Other Contributions

The LDRCT project supports free markets and broad-based economic growth primarily through the socio-economic module and indirectly through the CO_2 work. The SE module has determined important hindrances to the development of a thriving livestock sector for Kazakhstan. The CO_2 module

produced a brochure detailing how Kazakhstan could participate in global carbon credit markets. These markets may provide an important source of government and private investment.

Mission objectives that this project complies with include: (1) the assessment and dissemination of improved livestock and rangeland management technologies to conserve natural resources, mitigate global warming, and improve welfare of smallholders in Central Asia; and (2) the evaluation of alternative policy scenarios to promote dissemination and adoption of environmentally friendly, low-cost livestock production technologies.

The activities of the 2002-03 year will contribute towards these long-term targets by:

- widely distributing the Country Almanac (which includes an electronic database of soil, vegetation, and weather layers) to be used directly by decision-makers and policymakers, also used as the basis for the modeling phase of this project (Activity One).
- developing the human capacity and institutional frameworks necessary for this project to have long-term impacts beyond its active period (all activities).
- creating data-based models of C flux, forage production, and weather for the simulation of ecological scenarios and an assessment of the role of rangelands in the global C cycle (Activity Two).
- modeling smallholder animal production systems and enterprises and identifying limiting factors (Activities Three and Four).
- identifying the role of different agricultural practices on the loss of soil C in northern Kazakhstan, and proposing integrated crop-livestock systems that incorporate rotation with forages that improve soil condition, reduce erosion, and capture atmospheric carbon (Activities One and Two).
- facilitating the direct involvement of producers in conducting research and by disseminating the information both to decision-makers and policymakers and producers.

Leveraged Funds and Linked Projects

We estimate that we obtained $150K in matching (mostly in-kind) and $300K of leveraged funds in cash. These funds include the cash match from USGS-EROS Data Center and the cash from the USDA-ARS for the integration of the United States and Central Asian carbon flux networks.

Funding from IFAD ($205K) continued to support the farm monitoring, alternative forage activities, and animal production modeling activities of the project.

Training

Degree Training

Karen Olmstead, M.S., 2003, Biology and Agricultural Engineering, A Simple Model of Rangeland Productivity in Southern Idaho Using Landsat Images, University of California, Davis.

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

Jorge Perez, Ph.D., 2004, Agricultural Ecology, Carbon and Water Vapor Flux Patterns in Four Agroecosystems of Northern Kazakhstan, University of California, Davis.

Short-term Training

ACT A-Where workshop for representatives from agricultural government, research, and non-governmental agencies was held in late October 2002 in Almaty, Kazakhstan together with CAREC. 33 participants from Kazakhstan, Turkmenistan, and Uzbekistan with representation from the ministries of energy/oil, natural resources, and economics attended the trainings.

Dr. B. Mardonov was trained at UC Davis in the application of the alkane marker method for diet composition measurements. He was also trained in basic methods of ruminant nutrition field research (total collection, digestibility measurements, and basic laboratory work).

A seminar on the basics of GIS was organized at Samarkand State University with the biological faculty for both teachers and students.

Classes and training on GIS Methods and their use in research were held for postgraduate students, bachelors, and masters of the Department of Ecology of Desert Pastures.

Collaborating Personnel

United States of America

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

Richard Howitt, Professor, University of California, Davis.

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

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

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

Richard Plant, Professor, University of California, Davis.

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

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

Bruce Wylie, Principal Scientist, EROS Data Center, South Dakota.

Bradley Reed, Principal Scientist, EROS Data Center, South Dakota.

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

Sinisha Ivans, Graduate Student, Biological and Irrigation Engineering Dept., Utah State University, Logan, UT.

Mary Dalsin, Project Coordinator, University of California, Davis.

Mimako Kobayashi, Graduate Student, University of California, Davis.

Adam Wolf, Post Graduate Researcher, University of California, Davis.

Jorge Perez, Graduate Student, University of California, Davis.

Karen Olmstead, Graduate Student, University of California, Davis.

Girma Getachew, Graduate Student, University of California, Davis.

Kazakhstan

Kanat Akshalov, Deputy Director, Barayev Institute of Grain Farming.

Iliya Alimaiev, Deputy Director, Research Institute of Feed Production and Pastures.

Kasim A. Asanov, Director, Research Institute of Feed Production and Pastures.

Nurlan Malmakov, Researcher, Institute of Sheep Breeding.

Alexandr Nikolaenko, Information Manager, Central Asian Regional Environmental Center.

Gaziz Sarbasov, Researcher, Institute of Sheep Breeding.

Azimkhan A. Satybaldin, Professor, Ministry of Science-Academy of Science RK.

Zhapar Zhambakin, Director General, National Federation of Private Farmers of Kazakhstan.

Turkmenistan

Habibulla Atamuradov, Director, National Institute of Deserts, Flora, and Fauna.

Muhamet Durikov, Researcher, National Institute of Deserts, Flora, and Fauna.

Valerii Nikolaev, Researcher, National Institute of Deserts, Flora, and Fauna.

Ogultach Soyunova, Researcher, Institute of Economics, Turkmenistan.

Uzbekistan

Rasulmat Khusanov, Director, Uzbek Research Institute of Market Reforms Ministry of Agriculture.

Bakhtiyor Mardonov, Range Scientist, Samarkand Division of the Academy of Sciences.

Tolib Mukimov, Researcher, Institute of Karakul Sheep Breeding and Desert Ecology.

Kristina Toderich, Researcher, Samarkand Division of the Academy of Sciences.

Alfia Shakirova, Graduate Student, Samarkand Division of the Academy of Sciences.

Muhabat Shakirova, Graduate Student, Samarkand Division of the Academy of Sciences.

Toshpulot Radjabov, Graduate Student, Samarkand Division of the Academy of Sciences.

Farhod Babadjanov, Graduate Student, Samarkand Division of the Academy of Sciences.

Oksana Zemcova, Graduate Student, Samarkand Division of the Academy of Sciences.

Denis Rahimov, Graduate Student, Samarkand Division of the Academy of Sciences.

Olga Dubovik, Graduate Student, Samarkand Division of the Academy of Sciences.

International

Arieh Brosh, Researcher, New Ya'ar Research Center, ARO, Israel.

Gustave Gintzburger, Researcher, CIRAD Montpellier.

Collaborating Institutions

United States of America

EROS Data Center – USGS
47914 252nd Street
Sioux Falls, SD 57198
Phone: 605-594-6078
Fax: 605-594-6589
E-mail: wylie@usgs.gov

South Dakota State University
Department of Biology/Microbiology
Box 2207B, Ag. Hall 304
Brookings, SD 57007-0595
Phone: 605-688-4925
Fax: 605-688-6677
E-mail: gilmanov@ur.sdstate.edu

University of California, Davis
Department of Agronomy & Range Science
Davis, CA 95616
Phone: 530-754-4083
Fax: 530-752-4361
E-mail:ealaca@ucdavis.edu, mcarpenter @ucdavis.edu

USDA-ARS Forage and Range Research Laboratory
Utah State University
Logan, UT 84322-6300.
Phone: 435-797-3067; 435-797-3385
Fax: 435-797-3075
E-mail:daj@cc.usu.edu

Utah State University
Dept. of Forest, Range and Wildlife Sciences
Logan, UT 84322-6300, U.S.A.
Phone: 435-797-3385
Fax: 435-797-3075
E-mail: nick.saliendra@usu.edu

Turkmenistan

Academy of Sciences of Turkmenistan
15 Gogol Street
Ashkhabad, 744000 Turkmenistan
Phone: 993-13-55464 or 351439
Fax: 993-12-357342 or 351439

National Institute of Deserts, Flora, and Fauna
15 Bitarap Turkmenistan Street
Ashkhabad, 744000 Turkmenistan
Phone: 993-12-357298 or 395427
Fax: 993-12-353716
E-mail: crsptur@online.tm

Uzbekistan

Academy of Sciences of Uzbekistan – Samarkand Branch
Samarkand, Uzbekistan
Phone: 998-66-33-58-11
Fax: 998-662-31-00-39
E-mail: mardonov@online.ru

Central Asia Regional Office - ICARDA
6 Murtazaeva St. / P.O. Box 4564
Tashkent, 700000 Uzbekistan
Phone: 998-71-1375259
Fax: 998-71-1207125
E-mail: pfu-tashkent@icarda.org.uz

Karakul Sheep Research Institute
47 Mirso Ulugbek St.
Samarkand, Uzbekistan
Phone: 998-66-2333279
Fax: 998-66-2394993

Uzbek Livestock Research Institute
Poselok Krasniy Vodopad
Tashkent Region, Kibray
Contact: M. Ashirov, A. Abdusattarov
Phone: 998-71-26433-07
Fax: 998-71-1394993 (USPCA)
E-mail: cac-tashkent@icarda.org.uz

Uzbek Sericulture Research Institute
Ipakchi St. #1
Shaihantaur Region
Tashkent, 700055 Uzbekistan
Contact: Yuldashev
Phone: 998-71-2400456

Uzbek Research Institute of Market Reforms
Ministry of Agriculture
28 Druzba Narodov St.
Tashkent, 700097 Uzbekistan
Phone: 998-71-2768600

Kazakhstan

Barayev Research Institute of Grain Farming
Akmolinskaya Oblast
Barayev Street # 6
Shortandy-1, 474070 Kazakhstan
Phone: 731-63-121950
Fax: 731-63-121270
E-mail: kanat@kepter.kz

Central Asian Regional Environmental Center
Orbita 1 # 40
Almaty, 480043 Kazakhstan
Phone/Fax: 732-72-292619
E-mail: carec@carec.kz

Ministry of Science-Academy of Science RK
79 Ablai Khan Ave.
Almaty, 480091 Kazakhstan
Phone: 732-72-625217, 623365
Fax: 732-72-623831
E-mail: nacar@itte.kz

National Federation of Private Farmers of Kazakhstan
15 Republic Square
Almaty, 480013 Kazakhstan
Phone: 732-72-631390
Fax: 732-72-630900

Research Institute of Feed Production and Pastures
51 Jandosova St.
Almaty, 480035 Kazakhstan
Phone: 732-72-214586
Fax: 732-72-621757
E-mail: alimaev@nursat.kz

Research Technological Institute of Sheep Breeding
Mynbaevo Village
Almaty Oblast
Kazakhstan 483174
Phone: 732-72-702202
Fax: 732-72-623831
E-mail: nurlan1@nursat.kz

International

CIRAD Montpellier
2 Place Pierre Viala
34060 Montpellier, France
Phone: 330-49-9612200
Fax: 330-49-9612940

International Centre for Agricultural Research in Dry Areas (ICARDA)
PO Box 5466
Aleppo, Syria
Phone: 963-21-213477
Fax: 963-21-213490

New Ya'ar Research Center
Agricultural Research Organization (ARO)
Israel
Phone: 972-49-539500
Fax: 972-49-836936
E-mail: brosha@volcani.agri.gov.il

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Principal Investigator

Lead Principal Investigator. Emilio A. Laca, Agronomy and Range Science, University of California, Davis, One Shields Avenue, Davis, CA 95616. Phone: 530-754-4083; Fax: 530-752-4361; Email: ealaca@ucdavis.edu.

Linking Sheep Producers and Markets: The Role of the Kyrgyz Sheep Breeders Association in Evaluating and Promoting Profitable Sheep Marketing Strategies

Narrative Summary

Interviews with sixty-one sheep and wool producers in Talas Oblast demonstrate the economic advantages of a meat breed production strategy, based on traditional Kyrgyz fat-tailed sheep. Although less remunerative per head than the meat strategy, fine wool and mixed production strategies also demonstrate profitability at 2003 prices. The findings confirm the hypothesis that there are potential areas for increasing the production value and returns for a "dual-purpose" strategy. At the sectoral level, household flocks of Kyrgyz fat-tailed breeds for domestic meat markets are currently the most widespread segment of production, providing a major protein source in household consumption. Strong urban demand is reflected both in markets and in the proliferation of new restaurants in Bishkek and tourist destination Cholpon-Ata.

Wool producers represent a smaller, more commercially oriented segment of production. Their cost structure demonstrates a different relationship to pasture access and veterinary costs compared to meat producers, who spend less on pasture rental and other costs with their highly adapted Kyrgyz fat-tailed and Gisarski breeds. Feed costs are also slightly higher for the wool producers on average than for meat producers.

For wool producers, the survey results underscore the desirability of increasing meat sales, and the importance of achieving quality premiums for wool to maximize sale prices, which are below world market levels. The upturn in wool price suggests better prospects next year. For meat producers, the results raise questions about new opportunities in domestic markets and exports to Kazakhstan, Russia, and the region.

The introduction of Regulation #360, "On the Procedure of Lease and Use of Pastures," in June 2002 raised questions of pasture management that are directly relevant to both the ecology and sustainability of the pastures, as well as to the production costs for the different groups of producers (meat, wool, and mixed). Results of the project's analysis are helping the Kyrgyz Sheep Breeders Association (KSBA) to target its service provision and policy advocacy activities. An extension brief describing this research is being distributed through KSBA's local groups and the Rural Advisory Service.

Research

Activity One: Economic Comparison of Wool, Meat, and Mixed Flocks

Problem Statement and Approach. Under the current conditions of changing world market prices for wool, the relative profitability of producing mainly fine wool, meat, or both is not entirely clear to either producers or marketers in Kyrgystan. The project hypothesized that the meat strategy is still the most common and profitable, but that dual purpose strategies, combining both wool and meat sales, would have the greatest potential to maximize income levels if they could be adapted to Kyrgyz conditions.

Progress. The project collected quantitative data from 61 sheep producers in Talas Oblast. Production budgets were calculated for each operation and a comparison of profitability made for each of the three groups: meat, fine wool, and mixed. The survey results were used to begin modeling alternative farm budget scenarios with changing parameters for world prices for wool and meat. Results on the price-quality sales data indicate that Kyrgyz producers are obtaining prices well below world levels; however, under the assumption that the fine wool group in the sample can differentiate lots of 23-micron wool, current Australian prices for 23-micron wool (USD $7.00 per kilogram clean) suggest that wool producers with this quality of fiber could double their profitability if they market volume contracts certified in narrow fiber diameter ranges.

Table 1 - Sheep Production Budget 2002.

Sheep Production Budget (from sample averages 2002)					
1,000 soms per 100 head flock (USD $1 = 45 Som)					
			N=20	N=20	N=21
			Mixed	Meat	Wool
Income Total			**68.7**	**85.7**	**72.9**
	Sale of Wethers, Rams and Lambs		37.1	53.3	37.7
	Sales of Culled Ewes		19.2	21.9	16.6
	Sales of Young Ewes		6.5	8.2	2.2
	Sales of Pelts		1.5	1.2	1.5
	Sales of Wool		4.4	1.1	14.9
Costs Total			**36.8**	**41.3**	**52.5**
	Shearing		0.9		1.4
	Veterinary Services		4.4	2.8	5.8
	Artificial Insemination				0.7
	Fuel		4.6	9.0	10.3
	Feed		20.9	20.7	22.2
	Pasture Rent and Maintenance		0.4	0.7	4.9
	Sales Costs of Wool		0.0	0.0	0.2
		Classing			0.1
		Storage			0.0
		Commission on sales			0.0
	Transportation		5.5	8.0	7.1
Profit			**31.9**	**44.4**	**20.4**

Source: 2002 survey in Talas Oblast.

These findings do not confirm the project hypothesis that the highest profitability in production comes from a dual purpose strategy of combining animal sales with the sale of fine wool, using an objective measurement of fiber and quality management. The findings show that all three strategies are profitable, with the meat strategy comprising the highest return approach of the three on a per head basis (44,400 som/100 head/year versus 31,900 som/100 head/year for the mixed group, and 20,400 som/100 head/year for the wool group, USD $1.00 = 45 som). While the Kyrgyz fat-tail meat breed strategy generates the highest return on a per head basis, the wool producers have the highest average net income per operation (61,062 som with flocks averaging 226 heads), versus a net income of 51,998 som (with an average size of 91 heads) in the meat group. The profitability of the mixed flock strategy (39,213 som with an average flock size of 96 heads of Kyrgyz semi-coarse wool breed) is the lowest of the three groups. Intensive management of animal selection and breeding is not practiced by the operators in the Talas sample, suggesting there is potential for maximizing dual purpose income if such techniques are followed.

The findings also do not confirm the hypothesis that Kyrgyz wool can command international prices for its producers if it is marketed according to international standards. The results of 2002 wool sales to KSBA and local buyers show that a subset of producers are receiving somewhat higher ranges of global prices for higher quality wool (the highest price in the sample is $1.36/kg of grease wool in June 2003), but only a little wool was measured objectively during the spring 2002 clip recorded in the sample. Most wool producers are receiving intermediate prices within the low market range.

The spring of 2003 was the first year during which KSBA used an OFDA2000 machine to take objective measurements of fiber diameter. This was the first year in which KSBA groups began sorting wool according to objective measurements. The project completed a market outlook (see Activity Two below), based on research done by KSBA with the University of Wisconsin-Madison (UW) team. This market outlook predicts rising world demand for the 21-25 micron diameter wool, which is what most operations in the sample are producing, suggesting that the wool producers' relative profitability may improve as the world price strengthens.

Activity Two: Market Outlook Report

Problem Statement and Approach. The market outlook activity focused on understanding changes in Australian markets based on stocks and drought conditions, the relocation of U.S. and other western textile industries to China, German textile demand, and other factors.

Progress. The world price conditions for wool continued to improve during 2003. The outreach material produced by the project described this trend, emphasizing the narrowing gap in price between very fine fiber diameters and wools in the 21-25 micron range. These improving price conditions will likely increase the relative profitability of the wool sector and perhaps exceeding the outlook report's expectation. The report gives Kyrgyz producers a positive outlook for both wool and meat in the short-term but does not provide specific price forecasts for 2004.

In an additional outreach activity, Mogilevsky and Childress participated in a conference on the relationship between Kyrgyzstan and the World Trade Organization (WTO), in which the issue of temporary export restrictions for raw wool in Kyrgyzstan was brought to the attention of officials in the Ministry of Industry and Trade as an example of a counter-productive policy for farmers.

Gender

The project does not have any explicit gender focus. All of the sampled producers are headed by males. The project has not investigated the intra-family dimensions of sheep production activities, income distribution, or the differences in women's work in the three types of households.

Policy

The Kyrgyz researchers are engaged with local leaders and national policymakers in a dialogue about agricultural policy and the future of the sheep industry from marketing and ecological perspectives. They are engaged in supporting KSBA's policy positions on temporary restrictions on raw wool exports, value added tax (VAT) policy, and export standards for wool. Additionally, Childress presented findings about pasture management and Rakaev was a panelist at the November 5 National Conference on Land Reform.

Outreach

The project is targeting local sheep producers to read the brochure produced about the research by KSBA. The purpose of the outreach activity is to provide producers with a baseline of quantitative knowledge about their position in the local industry as background for future marketing and production decisions. The outreach activity embodies KSBA's commitment to act as an objective source of information for producers, as well as a buyer of wool.

Developmental Impact

The project's developmental impact is small by itself, and is intended to be a contributing element to a larger set of KSBA activities that are strengthening the linkages between producers and markets. The findings about the economic advantages of traditional Kyrgyz breeds underline the sustainable characteristics of these breeds, and suggest that it may be valuable for KSBA to seek ways to increase service provision for this group. The project's contribution to understanding pasture management questions (for example, the fragmentation in rental payment for pasture between commercial and household production) is also contributing directly to policymaking for sustainable pasture management.

Contributions to U.S. Agriculture. Contributions to U.S. agriculture in the form of testing services and consulting opportunities are likely to flow out of the project's contribution to establishing marketing expertise in KSBA. KSBA is known to U.S. agriculture through the Farmer-to-Farmer Program of Winrock International, which has provided KSBA with three volunteers from U.S. agriculture since 1997. Wildlife ecologists from the U.S. are currently working with local KSBA groups on wolf management.

Contributions to Host Country. For Kyrgyzstan, these results fill a research gap, important during a period of renewed attention to the role of the sheep sector in the Kyrgyz economy. The results also support KSBA's planning and involvement with farmers. Through systematic data collection, the research has enhanced KSBA's ability to understand the economics facing producers in its region, to plan strategically as an organization, and strengthen its policy advocacy activities. KSBA is continuing to update information in the producer database to establish a longer-term monitoring of sales. The results suggest that focusing market development efforts exclusively on wool would be a mistake, ignoring the most profitable and dynamic parts of the sheep sector.

Linkages and Networking. The project established collaboration with a number of projects, agencies, and actors active in rural development in Kyrgyzstan. These include the BASIS CRSP, the Checchi Commercial Law Project, the Chemonics Land Reform Project, Winrock International Farmer-to-Farmer Project, Giprozem, Gosregister, Ministry of Agriculture, Water Resources and Agro-Industry, the Rural Advisory Service, Swiss Development Cooperation, the German Agency for Technical Cooperation (GTZ) Cashmere Pilot Project, World Bank Village Investment Project, Agriculture Services Support Project, and the Land Registration Project. Presentations based in part on the project research were made by Childress on October 4 at Harvard University to the Central Eurasian Studies Society Annual Meeting and by Childress and Rakaev to the National Conference on Land and Agrarian Reform, sponsored by USAID. Held on November 5

in Bishkek, the conference was attended by local leaders, representatives of the Jorgoku Kenesh, officials from Gosregister, Giprozem, and the Rural Advisory Service, as well as staff of USAID/Bishkek and USAID/Almaty.

Other Contributions

The project supports the USAID/Bishkek objective of the development of free markets and broad-based economic growth (i.e., agribusiness and private enterprise). The project contributes to this objective by assisting in the development of one of Kyrgyzstan's few farmer associations, which helps develop the institutional mechanisms for linking producers and markets through credit provision, marketing, village development, and policy advocacy. The project displayed a concern for individuals, providing incentives for regional managers of KSBA to take an active role in the research, deepening KSBA's contact with its farmers/members and providing on-the-job training for key researchers like Akulbek Rakaev. The transparency and openness of data-sharing demonstrated in the direct dissemination of results to producers contributes to the U.S. State Department's objective of public information freedom in Kyrgyzstan and inclusive national dialogue about development priorities and policy issues.

Leveraged Funds and Linked Projects

The project did not leverage any funds directly, although it provided a platform for establishing linkages with two other GL-CRSP small grant projects (University of Wisconsin/Dave Thomas and Liba Brent, and Colorado State University/Kathy Galvin and Carol Kervan) for the preparation of a three-year follow-on GL-CRSP project, "Developing Institutions and Capacity for Sheep and Fiber Marketing in Central Asia," beginning in 2003-2004. The project contributed to a set of linked projects carried out by Childress: USAID Rapid Appraisal of Land Legislation ($42,000); BASIS Institutional Innovations for Investment in Kyrgyz Agriculture ($150,000/year); and the DFID/Institute of Development Studies Group Farming in Kyrgyzstan and Romania ($50,000).

Training

Per plan, the small grant program was not involved in providing any organized training activities. It provided on-the-job training for KSBA in data collection, analysis, and preparation of extension briefs. Roman Mogilevsky of Cemter fpr Economic and Social Research (CASE)-Kyrgyzstan and Childress provided this training.

Collaborating Personnel

Malcolm Childress, University of Wisconsin-Land Tenure Center.
Akulbek Rakaev, KSBA.
Temirkuliev Temirku, KSBA.
Alumbek Erdolatov, Center for Economic and Social Research-Kyrgyzstan.
Roman Mogilevsky, Center for Economic and Social Research-Kyrgyzstan.

Collaborating Institutions

University of Wisconsin-Madison
Land Tenure Center
1357 University Avenue
Madison, Wisconsin 53715
Phone: 608-262-3657
Fax: 608-262-2141

Kyrgyz Sheep Breeders Association
Ul. Profsoyuznaya 43
Bishkek, Kyrgyzstan
Phone/Fax: 996-312-210761

Center for Economic and Social Research-Kyrgyzstan (CASE-Kyrgyzstan)
Bishkek, Kyrgyzstan
Phone/Fax: 996-312-217947

Publications

The project plans to submit a manuscript to a U.S. journal later this year. The Russian language extension brief, "Sravnitelnoe analiz dohodnosti chastniye obsetvostbov khozyaistva, vzrashibaiyushii ovyets razlichnii napravleniye productivnosti" (Comparative analysis of profitability of private sheep farms from differing productive approaches), was published by KSBA and a thousand copies are being distributed to farmers and policymakers.

Principal Investigator

Lead Principal Investigator. Malcolm Childress, Land Tenure Center University of Wisconsin-Madison, Madison, WI 53715. Phone: 608-262-3657; Fax: 608-262-2141; Email: mdchildr@facstaff.wisc.edu.

Feasibility of Market Development and Support Services for Livestock Products in Kazakhstan and Kyrgyzstan

Narrative Summary

Kazakhstan and Kyrgyzstan, in common with the other Central Asian republics, had highly developed livestock industries which produced wool, other animal fibers and pelts, as well as meat. Following the disintegration of the Soviet Union, these industries, and the USSR market on which they were based, largely collapsed. The wool and fiber industries are now experiencing a revival. The region has a comparative advantage in producing livestock on an extensive basis. Rangelands cover more than 60% of the agricultural area, managed by herders with traditional skills. There is a genetic fund of indigenous and crossbred animals of economic value, and a depth of national research skills inherited from the Soviet period.

Regionally, wool production has remained steady since the year 2000 yet the prices remain low. Most wool and fibers go to the other Newly Independent States though China has become increasingly important to the trade. Household data from previous studies and our study findings show that wool, cashmere and camel hair are sold without the benefit of separation into coarse and fine wool and that of other fibers.

This project examined how livestock resources can be better exploited to meet new commercial demand as well as increase economic returns to producers. Focusing on a few high value products – fine wool and goat cashmere–the study investigated the information and technology transfers needed to improve marketability. The project reached the following development conclusions:

- Policy, research, and activities to improve incomes of livestock farmers must be targeted towards the comparative economic advantages of different types of livestock in particular ecological regions.
- Smaller-scale livestock owners need additional income sources from their animals. Their rates of live animal sales to markets are not sustainable as high sales levels eventually deplete small flocks, leading to loss of livelihoods.

Producers with smaller flocks will gain by selling high value animal fibers, as these can bring an additional, recurrent, and often significant income per head of animal owned. These products can also be transported more cheaply than live animals to markets. The development of cashmere marketing will especially benefit poorer farmers in Kazakhstan's vast desert regions and Kyrgyzstan's mountain zones, where indigenous goats thrive and there are very few income opportunities apart from livestock.

Research

Problem Statement and Approach. This project addressed the problem of how to develop markets for fine wool and cashmere that can:

- Increase profitability for producers and the national commercial sectors.
- Meet industrial quality standards.
- Capture niche markets for high-value products on the world market.

- Develop the comparative advantages of unique animal genetic resources and the natural rangeland resource.

The region has a comparative advantage in producing livestock on an extensive basis. Rangelands cover more than 60% of the agricultural area, managed by herders with traditional skills. There is a genetic fund of indigenous and crossbred animals of economic value, and a depth of national research skills inherited from the Soviet period. Recent assessments of the market for livestock products in these two countries had identified the greatest potential in fine sheep wool and goat cashmere, with camel hair and pelts to a lesser degree (Kerven et al. 2002; SLLPC/ DFID 2001).

Expansion of meat markets currently has much less potential, for several reasons. Firstly, in the transition to a market economy, livestock producers and traders spontaneously responded to demand for meat from the new private urban markets. Sales income from live animals quickly overtook sales of wools, fibers, etc. in importance to farmers' income. But the majority of rural families now own insufficient animals to continue depending on animal sales for subsistence. This follows from the decollectivisation of state farms, where in Kazakhstan and Kyrgyzstan, up to 70% of small stock were lost.

This assumption of the problem model, that live animal sales were the major source of farmers' income, was modified as project survey results show that for farmers with fine wool sheep, cash income from wool can be quite significant (18% in one sampled region of Kazakhstan) while sales of cashmere can be very significant (47% of income) for goat-owners in the sample villages of southern Kyrgyzstan. Nevertheless, smaller-scale flock owners with up to 30 head have to sell an unsustainable proportion of 60% of their sheep in the Kazakhstan sample. In Kyrgyzstan, sampled households in the poorer southern region sold 46% of their sheep.

The potential for meat export is severely impeded by the breakdown in national veterinary controls (Vidon 1999). Few countries will allow meat imports without assured veterinary certification, although Russia is now reported to be buying meat from Kazakhstan. There was an opportunity to investigate this assumption of the problem model during a field trip to Kazakhstan's northern border with Russia, in Kostanai Oblast. In a meeting with senior provincial agricultural officials, the officials noted that the province produced 50% more meat than was required. The question was raised about whether meat was exported to Russia. The answer was equivocal. The officials, who included state veterinary officers, commented that veterinary inspection certification was required for exports. They argued that this would need more financial support for the veterinary service, as there was *brucellosis* present among the livestock. Finally, the officials concluded that meat was not exported to Russia but to western Kazakhstan, where meat prices were higher.

In the last couple of years, demand for fine/ semi-fine wool -- the most commercially valuable kind -- has increased in both countries, for two reasons. Firstly, Russia has begun importing fine wool again, after using up stockpiles from the early 1990s following the collapse of their processing industry. Secondly, foreign investment has revived some of the domestic processing facilities, at Tokmok in Kyrgyzstan and Taraz in Kazakhstan, as well as a number of smaller facilities. Rising demand for fine wool has meant a doubling (and more) of producer prices within both countries for fine and semi-fine wool since 1998.

There are few purebred fine wool sheep left, as during the economic crisis of the early reform period, newly privatized farmers crossed any remaining Merinos with the indigenous fat-rumped meat breeds. At that time, the market value of meat type breeds for slaughter was much higher compared to wool breeds. However, with recent demand and rising prices for fine wool, some farmers have considerable interest in regaining good wool breeds. This assumption of the problem model was tested by comparing prices for the different breeds at the livestock market in Taraz, a major provincial city in Jambul Oblast of southern Kazakhstan, a center of fine wool Merino sheep production in the Soviet period. In spring 2002, the price of a young ewe of Kazakh meat-type breed was almost double ($60) that of a Merino-type young ewe ($33). However, the price of a three year-old ram of each breed was the same at $86. Larger-scale farmers buying at this market were interested in obtaining a good-looking Merino-type ram to upgrade their fine wool production.

There are also a number of coarse-wooled sheep breeds such as the Gissar breeds, the Kyrgyz Alai, and the Karakul, in the desert regions of Kazakhstan. All local meat-type breeds are coarse-wooled in both countries. While coarse wool always had a lower value compared to fine wool, the price has become very low indeed -- a few cents a kg. -- due to lack of demand. There are thus limited prospects for developing coarse wool.

In the Soviet period, Kazakhstan and Kyrgyzstan each had several large factories for wool washing, spinning, and weaving. These fell into disuse post-1991, but in the past three to four years foreign investment and technical advice has rehabilitated some of these factories. But the quantity and quality of wool supplies remain a problem. The largest factories are not able to obtain sufficient domestic supplies of fine and semi-fine wool. Within Kyrgyzstan, for example, the largest factory at Tokmok had to import wool from Australia and South Africa. All these factories demand much higher production of Merino semi-fine wool to justify their capacity and recent financial investment.

Wool factories also require raw wool supplies to be graded according to industry standards. In the Soviet period, trained specialists at state collection centers carried out wool sorting, but newly privatized farmers do not have these skills. Processing factories are prepared to pay higher prices to producers for cleaned and sorted wool. But most farmers are not aware of the price differential for different grades, so in addition to lacking skills, they have no incentive to clean and sort wool, which would bring them higher prices. Therefore, there is potential to improve wool marketing by disseminating price information to producers, and training them in sorting wool.

When starting the project, the problem model was altered to put greater emphasis on investigating the potential for developing cashmere markets, with less focus on problems and solutions to wool marketing. Discussions were held with the University of Wisconsin teams carrying out the other GL-CRSP small grant projects, "Linking Sheep Producers and Markets" (Childress-Stobart team) and "Improving Market Infrastructure Through Wool Pools in Kazakhstan" (Thomas-Brent team). One of the outcomes was that the Colorado State University (CSU) team would focus on cashmere production and marketing in both Kazakhstan and Kyrgyzstan. Through further exchanges between the teams, it was agreed that the CSU team would seek to compare returns to producers in different regions from wool, cashmere, and live sales of sheep and goats. It was also agreed that in

order to increase coverage and avoid duplication, the CSU team would only collect basic data on wool production and marketing in one region of Kazakhstan (Jambul Oblast) that was not being covered by the Thomas-Brent team also working in Kazakhstan.

Goat down (cashmere). The indigenous goats of Central Asia produce fine down, which can be marketed as cashmere, a high-value commodity on the world market (Kerven et. al. 2002; Millar 1986). Cashmere production was not developed in the Soviet era, but breeding work developed angora mohair goats for state farm production in Kazakhstan and Kyrgyzstan (Dmitriev and Ernst 1989; Millar 1986). Researchers crossbred the native fine-downed goat with several Russian and Asian breeds, in order to increase the down yield per animal (Dauletbaev and Aryngaziev 1978; Almeev 1973). The down of the resulting crossbred goats had, however, a higher fiber diameter and other characteristics that make this fiber (known as cashgora) much lower value in the world market. Most private farmers now no longer have a pure strain of native goats. The down produced from these mixed breeds has accordingly less market value, compared to cashmere. Moreover, the crossbred goats are less hardy in the extreme winter conditions, thus costing private farmers more in fodder, and have a lower reproductive performance than the native goat (Aryngaziev 1998).

Fieldwork under this project identified some high quality native cashmere-producing goats in a district of Kyzl Orda Oblast, Kazakhstan. This strain has not been crossed with the Soviet mixed angora breed goat, and is therefore a valuable genetic resource for breeding high value cashmere stud goats for sale to farmers. At present, Kazakhstan has a small cashmere goat breeding project with senior national researchers from both the Kazakh and Kyrgyz livestock research institutes, which started in 2001 with British Embassy funding. Native cashmere goats from four regions of Kazakhstan are being evaluated for selection and breeding.

Since about 1998, commercial interest in Central Asian goat down (cashmere and mohair) accelerated, initially with Chinese purchasing. Meanwhile, newly privatized herders are now restocking with goats, having "turned the corner" from the massive small stock losses of the mid 1990s. On a pattern well documented in semi-arid Africa, goats are preferred for restocking after large-scale stock losses, due to their higher reproductive rate compared to sheep and cattle (Kerven et. al. 2003). As cashmere can be harvested each year, it provides farmers with a renewable income, compared to final live animal sales for slaughter.

The initial project problem model stated that there were "no large-scale cashmere processing facilities in either Kazakhstan or Kyrgyzstan." Research under this project has found that there are local firms doing first or second stage processing of raw cashmere prior to export. Starting a couple of years ago, several companies in Turkestan city, South Kazakhstan Oblast have been sorting raw cashmere into colors and separating out finer from coarser qualities, with technical assistance and financing from some European companies to which the sorted raw product is exported. In Almaty, Kazakhstan, the company Asutor has been buying and exporting cashmere but without washing or dehairing, as far as is known. In Kyrgyzstan, a company in Osh has been washing and dehairing cashmere with equipment and know-how supplied by Italy, to which two tons of dehaired cashmere was exported at a price of $30 per kg in 2002.

An unknown quantity of goat fiber is exported raw, mainly to China, at a relatively low price, thus losing potential value for the

producer countries. There remain investment opportunities for processing cashmere domestically; however, these require technology transfer and improved quality of supplies.

Progress. A questionnaire survey for 40 households in two contrasting regions of Kyrgyzstan was conducted by Abdrasulov Abdugani (Senior goat and sheep specialist, Kyrgyz Livestock Research Institute) in autumn 2002. We decided to increase the number of household surveys in Kyrgyzstan (from 30 to 40) to be more comparable to the Kazakh data. Dr. Abdugani is a colleague of Dr. Almeev, a co-PI on this project. Though Dr. Abdugani was not initially part of the project, his knowledge and expertise allow for excellent data collection.

The first region was chosen to represent an area within the more densely populated and urbanized northern region close to main markets, in which fine wool sheep were mainly kept in the Soviet period. This is Keminsky district in the northern province of Chui Oblast, where the two villages of Shabdan and Kaindy were chosen. Merino and Kyrgyz crossbred wool sheep are kept in this area and there is a demand for fine wool from the country's largest wool processing factory, Kasiet, in Tokmok town, one hour from the sampled villages (Figure 1a, 1b, and 1c).

The second region was selected to represent a sparsely populated rural area close to the Fergana valley and the border with Uzbekistan, in which goats were important to household economies. This was Batken district of Batken Oblast, in the extreme southwest of the country, at a distance of 1,000 km. from the capital of Bishkek. This oblast contains about 200,000 goats, 40% of all goats in the country, and farmers have been selling goat down for several years to traders from Uzbekistan and China. Two villages were selected: Aktatyr, 60 km. from the provincial center, and Aksai village, nearby.

Ten families were sampled in each village. The sample was based on the proportional distribution of sheep and goat ownership of villages within a household survey in Kazakhstan, to be compared to the Kyrgyz survey (DARCA 2002): 1-30 small stock = 4 families (40%); from 30 to 70 animals = 3 families (30%); from 70 to 150 = 2 families (20%); and more than 150 = 1 family (10%).

Informal interviews were carried out with key officials responsible for developing the livestock sector, including market development. These were gathered by the in-country national collaborators (Dr. Serik Aryngaziev, Kazakhstan, and Professor Almeev, Krygyzstan) and overseen by co-PI Dr. Nurlan Malmakov. Data was collected on wool production at the regional level, export of wool, cashmere sales of goat and camel hair, trading, and processors.

In Kyrgyzstan, Dr. Almeev interviewed seven traders and three national processors of wool and goat down, using a checklist of questions developed from the proposal. He carried out these interviews in Naryn town (Naryn Oblast), Bishkek, Akshiski Rayon (Jalal Abad Oblast), and Tokmok town (Chui Oblast). He obtained national statistics on the export of wools and goat down from 1990 to 2002 and a list of all officially registered traders and traders in wools and fibers operating with the country. He noted that many traders are not officially registered, so as to avoid paying tax, but the largest traders and processors are likely to be registered.

Dr. Almeev's report was translated into English by a Kyrgyz translator, Gulbara Tagaeva, who has previously worked on the topic of goat down and who assisted the team during C. Kerven's visit to Kyrgyzstan in August 2002.

Data Analysis. Data analysis began in February 2003 when Kazakh scientists, Dr.

Nurlan Malmakov and Mr. Aidos Smailov, traveled to Fort Collins for two weeks of data analysis training with Dr. Michael Lacy, Department of Sociology, Colorado State University. Data on the current producer marketing patterns of live animals, fibers, and skins was analyzed from an existing sample survey of 40 livestock-producing households in Kazakhstan (DARCA 2001) and from the new survey of 40 such households in Kyrgyzstan.

Results. In Kyrgyzstan, the situation in the southern goat-keeping region contrasts sharply with the north. In the south, farmers

Figure 1a, 1b, and 1c - A view of the project's study region.

gained 87% of the income they would have gained from selling both sheep and goats, the total of which amounted to 47% of all income from small stock sales in 2001 (Figure 2). In the south, the contribution of income from cashmere sales is crucial, as it was in 2001, when cashmere prices were double those of 2002. On the other hand, sales of sheep wool are negligible from the southern region. It appears from the high sales rate of sheep in the southern region sample that farmers had to sell many more sheep compared to northern region farmers in order to gain income (Figure 3). Farmers in the more developed northern region probably have additional income sources from employment and crop farming. In the northern region, where fine wool sheep remain from the former state farms and there is a demand for this wool from the large Tokmok processing factory, farmers can gain some income from wool sales. But this is a small amount on average, equal to only 8% of cash income from livestock in 2001 and no income in 2002 when farmers did not sell their wool.

In Kazakhstan, there are similar contrasts between ecological regions. Among the sampled households, income from selling wool was a significant contribution only for farmers in the mountain foothill region near Almaty, where fine wool breeds of sheep are retained from the state farm period; here farmers gained on average 18% of their cash income from wool sales in 2001 (Figure 4). Income from selling goat fiber was not an important source of income in any region, in contrast to the Kyrgyzstan southern region sample. This is because private trading in cashmere has been more developed in central and southern Kyrgyzstan since 1997. In contrast, in southeastern Kazakhstan, Chinese-sponsored buyers only began purchasing in 2000 and did not penetrate rural areas as thoroughly as in Kyrgyzstan during 2001. Furthermore, Kazakh farmers did not comb the cashmere from their goats, as in southern Kyrgyzstan, and would have received less income from selling whole goat fleeces.

Figure 2 - Sales rate of sheep and goats by region.

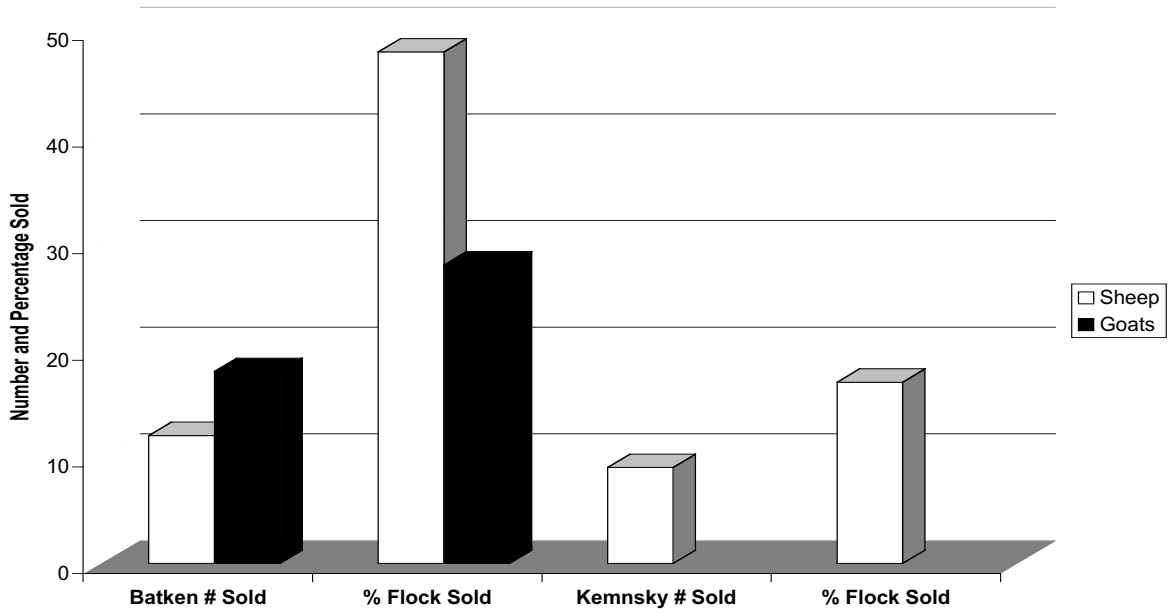


Table 1 - All privately-owned sheep and goats in sampled villages (40 households).

Mean Number and Range	Standard Error of Mean	Median Number	Modal Number	First 40% Households Owned	Next 30% Households Owned	Next 20% Households Owned	Last 10% Households Owned
70 10-330	11.37	45.5	15	10-33	40-60	75-160	170-330

It is important to note that the results reported here did not include other sources of household income. These would include sales of cows, horses, milk products, and agricultural crops, as well as employment, self-employment, state pensions, and remittances from family members. This analysis had a limited aim of comparing income sources from wool, live animal sales, and cashmere sales from sheep and goats.

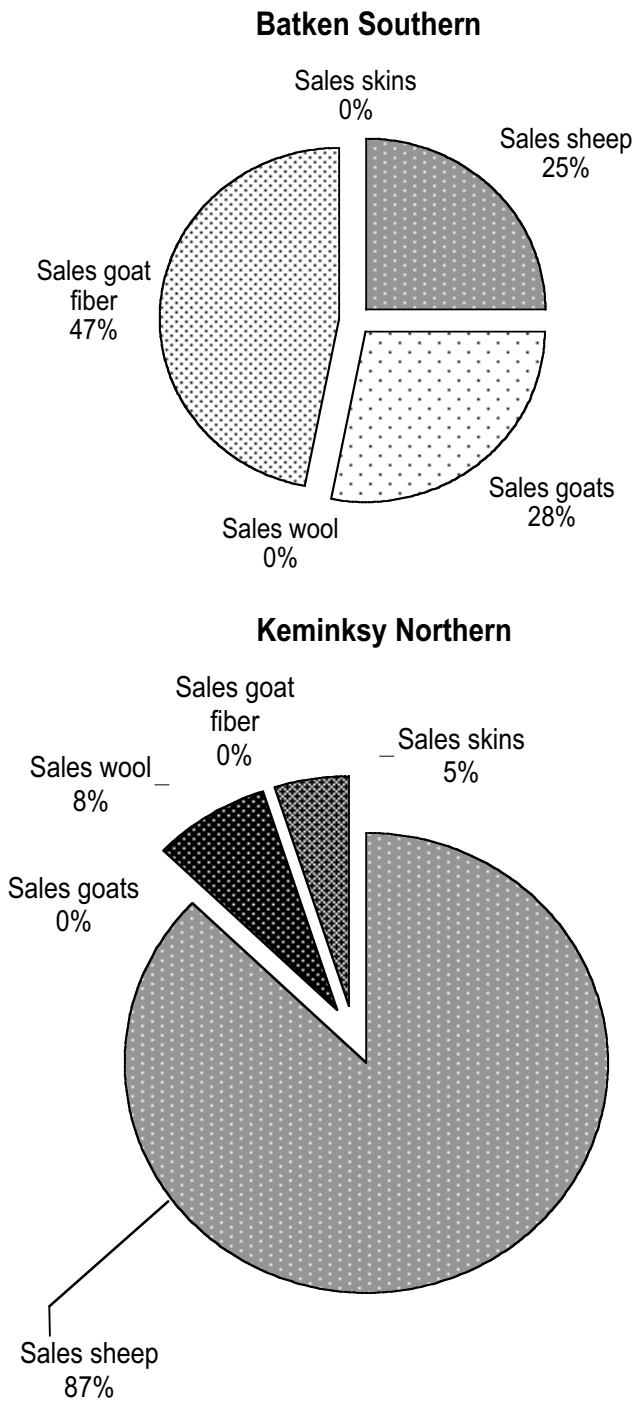
Total cash incomes from selling live animals, wool, cashmere, and skins were very different between owners of different flock sizes, ecological regions, and between countries. Thus for example, the largest scale owners, owning more than 200 sheep and goats in the Kazakh sample, obtained $12,400 in 2001, mostly from selling sheep. Households in the Chui Oblast sample in Kyrgyzstan obtained on average less than $390, the least income from these sources. Highest regional incomes were in the semi-desert area of Kazakhstan, with mean incomes of over $5,000. This area has the advantage of relatively good pastures and is within a couple of hours of the main profitable market of Almaty.

Survey results from Kyrgyzstan. Over the whole sample, the mean number of sheep and goats privately owned is 70, with a range from ten to 330 (Table 1). Three households owned more than 200 sheep and goats. The distribution of ownership in Table 1 indicates that we were successful in obtaining a sample that reasonably matched our target distribution described above. As can be seen, 40% owned less than 30 smallstock, 30% owned between 30 and 60, 20% owned from 75-160, while 10% owned from 170 to 330 small stock.

As expected, the pattern of ownership is quite different in the two sample areas of Keminsky and Batken (Table 2). Households in the northern sample of Keminsky had far more sheep than goats and were more likely to have sheep than goats, while Batken sample households were the reverse, with many more

Table 2 - Household ownership of sheep and goats, by villages.

Village, Region	Mean Private Sheep (# H/holds)	Range and Standard Dev.	Mean Private Goats (# H/holds)	Range and Standard Dev.
Aksai, Batken	10 (1)	Na	55 (10)	20-160 41.75
Aktatyr, Batken	28 (9)	3-120 37.24	69 (10)	10-300 86.63
Kaindy, Keminsky	53 (10)	10-160 47.58	15 (2)	10-20 7.01
Shabdan, Keminsky	57 (10)	5-250 72.60	17 (7)	5-50 15.77



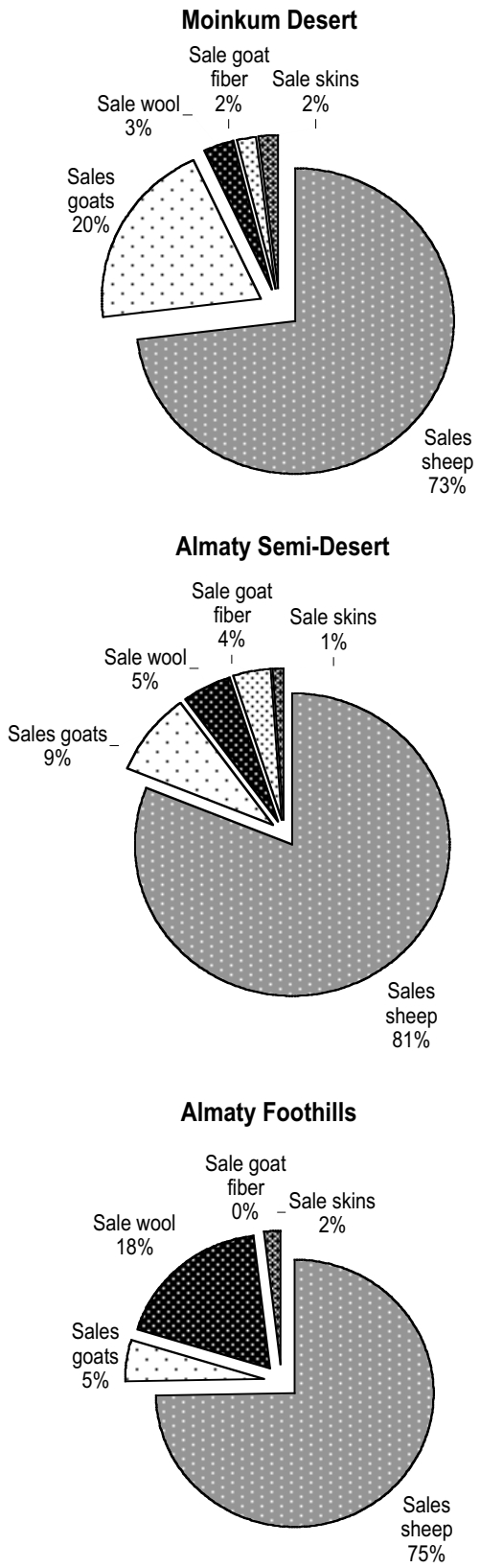


Figure 3 (above) - Sales for Batken Southern and Keminsky Northern.

Figure 4 (right) - Sales for Moinkum Desert, Almaty Semi-Desert, and Almaty Foothills.

Table 3 - Percentage of households owning capital assets used for livestock, by region.

% own / Region	Truck	Other Vehicle	Tractor	Barn	Yurt	Winter Home
Batken	0	45	5	35	5	5
Keminsky	40	10	40	65	35	15
Total (%)	20	28	23	50	20	10

goats than sheep and half the Batken sample having no sheep at all.

Breeds and management. The majority (85%) of sheep numbers across the whole sample were reported as local breed. This is probably a mixture of the fat-rumped indigenous meat types having dark coarse wool crossed with fine white wool breeds introduced in the Soviet period. Four farmers in the Keminsky sample reported they had Kyrgyz fine wool sheep (15% of all sheep).

Goat breed, when reported, was Kyrgyz downy (cashmere-producing). All households in the Batken sample combed the cashmere from their goats, and some also sheared. Combing is preferable, as the cashmere will receive a higher price when sold. In the Keminsky sample, 18 out of 20 households sheared their goats and none combed.

Ownership of capital assets for livestock management. The sampled households in the north (Keminsky region, Chui Oblast) more frequently had capital assets used for livestock compared to the southern villagers in Batken Oblast (Table 3). Trucks and tractors are used to haul livestock feed (hay) and livestock to market and family goods to seasonal grazing areas. Barns, winter homes, and yurts (traditional Central Asian nomadic tents) are used at seasonal grazing areas.

Only one of the 40 households received credit (USD $300) from a private company, which was used for buying livestock. Ownership of capital agricultural assets is positively associated with larger flocks of sheep, but not with the size of goat flocks (Table 4). This is because the owners of larger flocks of sheep are in the Keminsky sample and have more capital assets than the goat flock owners in the Batken sample. Field research in Kazakhstan indicates that tractors are the single most useful asset for livestock owners, as they can be used for multiple transport purposes to maintain livestock (Mathijs et. al. 2003).

Table 4 - Mean number private sheep by household asset ownership.

	Asset Owned	Asset Not Owned	Asset Owned	Asset Not Owned
Type of Asset	**Mean # Sheep**	**Mean # Sheep**	**Mean # Goats**	**Mean # Goats**
Tractor	92	18	18	39
Truck	73	25	10	41
Barn	51	17	47	22
Winter Home	68	31	45	34
Yurt	82	22	26	37

Use of non-family hired labor for livestock management. Northern households in Keminsky region were more reliant than Batken households on hired labor for livestock tasks (Table 5).

Households that hired full time herding labor had on average 48 sheep (standard deviation 40.6) in the case of hiring one full time herder, and 130 sheep (standard deviation 139.7) in the case of two full time herders. Households that did not hire herders had on average 14 sheep (standard deviation 27.6). No relationships could be discerned between the number of goats owned and hiring of full time herders.

When comparing the use of hired labor with capital assets (Table 3), it may be concluded that the Keminsky households generally have more capital and labor assets to use on their livestock.

Sales of wool and cashmere. No households reported wool income in 2002 when the price of wool was reported as from 10-25 Kyrgyz som (USD $0.20 to $0.50 kg). Keminsky farmers reported that in 2001, the price was 25 som (USD $0.50/kg.) for white wool from crossbred fine wool sheep, and 5 som (USD $0.10) for coarse wool from local sheep. Between 10-800 kg. were sold by households, with a mean of 121 kg. sold in 2001. No wool sales were reported for 2002. Batken households sold on average 27 kg. (ranging from two to 100 kg.) of cashmere in 2001 and also in 2002.

Sales of sheepskins and goat skins. All sampled households in Keminsky sold sheepskins to traders coming to the villages, at an average price of 80 som (USD $1.60) per skin. The mean income from sheepskins was USD $18, ranging from USD $3-128 per household. In Batken, six of the 20 households sold goatskins at an average price of USD $0.50 per skin, and two households sold sheep skins at USD $2 per skin.

Costs of marketing wool and cashmere. Households in Keminsky sold their wool to traders coming to their farms (19 out of 20), and none reported any costs of transporting wool to markets.

In Batken, only five of 20 households sold cashmere to a trader, the rest selling directly at Samarkandek market, one hour traveling time from the survey villages. Ten households (half the Batken sample) used rented transport, paying on average USD $2. Five households spent a mean of USD $14 (ranging from USD $2-35) using their own vehicles to transport their cashmere to market. However, in these cases, it is likely that trips to market included other purposes in addition to selling cashmere, which is lightweight.

Sales of live animals. Thirty-eight of the 40 households sold live animals. In Keminsky, four farmers sold to traders coming to their villages from Tokmok town, and the remaining 16 farmers took their animals to Tokmok for sale. No goats were sold.

In the Batken area, all animals were sold at Samarkandek market and none to traders coming to the villages. Prices for sheep are

Table 5 - Percentage of households that hired labor for livestock tasts, by region.

% hired / Region	Shearing	Part Time Herding	Hay Collection	Full Time Herding
Batken	25	20	0	0
Keminsky	100	15	100	95
Total (%)	63	18	50	48

USD $4-10 per head, up to 30% higher in the northern region, reflecting greater proximity to urban populations and their demand for meat (Table 5). Goat prices are half or one third those of sheep, where sold.

Sales rates of sheep and goats differed widely between the northern Keminsky region and the southern Batken region (Figure 2). Rates were calculated as the number of each type of animal sold through the previous 12 month period as a percentage of the number owned at the time of the interview (late 2002). Households in Batken had sold on average 46% of their sheep (mean 12.3 sold) and 28% of their goats (mean 17 sold), compared to Keminsky households that sold 16% of their sheep (mean 8.9 sold) and none of their goats.

Comparison of income from live sales and wool/ fiber of sheep and goats. As would be expected from samples taken in two distinct regions, household incomes from sales of live sheep, goats, wool, and goat cashmere varied between regions (Figure 3). Overall, the highest income was from the sale of live animals, but as noted in Figure 5, this was at the due to unsustainably high animal sales rates in the case of Batken households.

If we compare sales income from live sheep and wool within Keminsky district, only 8% of their small stock income came from wool sales and that was only in 2001. In 2001, no wool was sold by the time of this survey (in late autumn 2002 after the spring shearing which is usually followed by wool sales).

Table 6 - Mean sheep and goat sale prices (USD) by village.

Village, Region	Sheep Price	Range and Standard Dev.	Goat Price	Range and Standard Dev.
Aksai, Batken	nil	-	15	13-18 75.46
Aktatyr, Batken	31	20-44 373.24	18	11-24 274.37
Kaindy, Keminsky	41	36-44 134.99	nil	-
Shabdan, Keminsky	35	24-40 292.02	nil	-
Mean All	**36**	**20-44 336.46**	**16**	**11-24 215.57**

Table 7 - Mean household income from sales of live sheep, goats, wool, and cashmere per year by region, 2001 and 2002 (USD).

Region	Sale Sheep	Sale Goats	Sale Wool 2001[1]	Sale Goat Cashmere 2001	Sale Cashmere 2002 [2]	Total Sales Income 2001
Batken	166	190	0	311	160	667
Keminsky	340	0	30	0	0	388[3]
Mean All Villages (# Households)	375 (27)	254 (15)	32 (19)	328 (19)	18 (18)	-

[1]: No income from wool sales reported for 2002.
[2]: 2001 combed cashmere price kg mean = 611 som ($12);
2002 combed cashmere prices were lower at 348 som/kg ($7).
[3]: Includes a mean income of $18 per household from sales of sheepskins.

Comparing income sources for Batken sample households, when cashmere prices were particularly high in 2001, this brought in 47% of income; when prices were lower in 2002, cashmere sales still brought in 31% of income.

Survey results from Kazakhstan. Over the whole sample, the mean number of sheep and goats privately owned was 123 (±235) ranging from five to 1,600. The maximum number owned in the Kyrgyz sample was 360 head. The number of larger flock owners was greater in the Kazakh sample households, with six households owning more than 200 sheep and goats. These are analyzed separately in the following tables.

The proportion of goats in small to medium-sized flocks increased with decreasing annual precipitation, with 49%, 33%, and 19% of these flocks being goats in the desert, semi-desert, and foothills zones respectively (Table 8). Farmers with small and medium-sized flocks (from one to 70 head of combined sheep and goats) had approximately equal numbers of goats and sheep, whereas the owners of the largest flocks (more than 71 head) had almost five times as many sheep as goats.

The fine wool sheep breed was the main breed kept in the semi-desert (73%) and foothills (70%), whereas the Karakul coarse-wooled and lighter-weight sheep were the main breeds kept in the desert (71%). In the foothill and semi-desert zones, descendents of Soviet Merino-type breeds are still widely kept by farmers and yield much better income from wool than the Karakul breed of sheep kept in the desert which produces coarse black wool with very low commercial value (Table 9).

Household strategies with regards to sales of sheep and goats varied considerably between flock size categories. Households with the smallest flock size (1-30) had high rates of sheep sales (60%) but very low rates of goat sales (5%). The sales rate for goats however, was inversely related to flock size, increasing up to 85% for those in with 71-200 head, though decreasing to 67% among the largest flock owners (Table 10).

Prices received by farmers for wool, goat fiber, and live animals varied considerably by

Table 8 - Mean numbers and percentages of sheep and goats in flocks by ecological zone and annual precipitation.

	Desert		Semi-Desert		Foothills		S.E.D
Annual Precipitation (mm)	130		350		450		-
Sheep	42	51%	121	67%	55	81%	160.2
Goats	41	49%	60	33%	13	19%	42.1
Total	83	100%	181	100%	68	100%	-

Table 9 - Sales prices (USD) of sheep and goats and their products, by ecological zone.

	Desert		Semi-Desert		Foothills		S.E.D
Annual Precipitation (mm)	130		350		450		-
Sheep	42	51%	121	67%	55	81%	160.2
Goats	41	49%	60	33%	13	19%	42.1
Total	83	100%	181	100%	68	100%	-

Table 10 - Annual percentage of sheep and goat sales rates and increase by flock size.

Sheep	1-30	31-70	71-200	>201	S.E.D	P Value
Number Sold	6.6	6.8	23.5	270.1	64.4	<0.001
Percent Sales Rate	60	32	30	50		
Percent Annual Increase	27	0	214	46		
Goats	**1-30**	**31-70**	**71-200**	**>201**	**S.E.D.**	**P Value**
Number Sold	0.3	4.4	28.0	64.4	27.1	<0.01
Percent Sales Rate	5	21	85	67		
Percent Annual Increase	10	52	45	81		

Note: Sales rate calculated as number sold over past year as a percentage of number owned after one year of survey. Annual increase calculated as difference between number owned twelve months previously, numbers sold and slaughtered over the year and number owned after one year of the survey, which would include births and purchases.

ecological zone. This is partly due to the distance to the more profitable markets and is also a reflection of the different breeds of sheep kept in each zones (Table 12). The semi-desert and foothill zones are nearer to the main urban markets of Almaty and its peripheral towns. Karakul sheep are lighter in weight on average by 4-6 kg. compared to fine wool and fat-rumped sheep, and are kept in the desert zone, which is furthest from profitable urban markets. Karakul sheep, therefore, realized a lower market price than these other breeds that dominate in the semi-desert and foothills zones.

Table 11 - Mean total annual cash income (USD) from sheep and goats by flock size and ecological region, 2001-2002.

Flock Size			
1-30	**31-70**	**71-200**	**>201**
197	351	1,101	12,408
Ecological Zone			
Desert	**Semi-desert**		**Foothills**
3,123	5,114		646

The cash income derived from the sale of animals and their products by different flock size categories and in the three ecological zones is shown in Table 11, and the proportions in Figure 4. Income in-kind in the form of consumed animals and home use of wool and goat fiber was not valued for this analysis.

Total cash income from sheep and sheep products was far greater than income from goats, for all flock size categories. However, for the medium-sized flock group with between 31 to 70 sheep and goats, income from goats represented 36% of total income. For larger flock owners, goats provide between 16-19% of their cash income, while for the very smallest flock owners, goats provide insignificant cash income.

In 2001, the surveyed households received between USD $1.50 to 3.50 per kg. for selling goat fleeces to cashmere traders, depending on the production area. This price was much

better than that received in previous years, and was due to high demand by Chinese cashmere buyers in 2001.

Table 12 - Breed and weights of sheep breeds kept by ecological zone.

	Desert	Semi-Desert	Foothills
Kazak Fine Wool (KFW) (n = 216)			
Percentage	0	72.5	69.9
Live Weight Kg	-	55.8	57.2
Kazak Fat Rumped (KFR) (n=59)			
Percentage	0	14.7	21.9
Live Weight Kg	-	61.6	56.1
KFW x KFR (n=46)			
Percentage	17.4	12.8	8.2
Live Weight Kg	56.4	65.7	64.6
Karakul (n=155)			
Percentage	70.8	0	0
Live Weight Kg	53.1	-	-
Karakul x KFR (n=29)			
Percentage	11.8	0	0
Live Weight Kg	51.3	-	-
Total Percentage	100	100	100

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Gender

This project incorporates women researchers and women informants. K. Galvin is the P.I. on the project and C. Kerven is the project consultant. Several women were interviewed by the PIs during their trip in August 2002 and many more were represented in the household interviews from 2002-2003.

Women should be prime targets for training on wool and fiber development.

Kazakh and Kyrgyz women, in common with women in other parts of Central Asia, have traditionally processed livestock fiber products from sheep, goats, and camels into homemade articles such as carpets and clothing. Sometimes these articles are sold by women and provide a much-needed source of cash income. In handling wools and fibers, women comb, clean, sort, card, spin, weave, and knit, as well as make felt and knotted carpets. When male household heads were interviewed about production and sales of wool and other fibers, they frequently referred to their wives for accurate information, which rarely occurs in the case of other household livestock management questions. Central Asian women are more knowledgeable about and interested in wool and animal fibers, and should therefore be a focus of development efforts to improve marketability of these commodities.

Policy

This project has had the full support of the Kazakh Research Institute of Sheep Breeding in Kazakhstan and the support of the Kyrgyz Livestock Research Institute in Kyrgyzstan. National scientists received technical assistance on household and trader survey and informal interview techniques.

Outreach

Recommendations will be made for governments and the private sector on the priorities for allocating resources to develop livestock marketing support services.

Developmental Impact

Environmental Impact and Relevance. Though the project objectives do not directly address this question, it has become clear that market development needs to reflect regional ecological variations in the region. Both countries span major climatic and topographic regions with resulting agro-ecological zones. During and before the Soviet period, different breeds of livestock species were adapted to the particular physical conditions of each zone. Thus in the extensive deserts of southern Kazakhstan, the Karakul sheep and local breed of goat thrived in the past and continue to be the mainstay of livelihoods. In the better-watered mountain foothills and valleys of Kyrgyzstan and southern Kazakhstan, cross-bred Merino fine wool sheep were introduced to the Soviet state farms. Some of these are still retained though many are now crossed with local meat-type sheep breeds.

Agricultural Sustainability. This project examines how livestock resources can be better exploited to meet new commercial demand as well as increase economic returns to producers. The results of this study will be of interest to two livestock development projects in Kyrgyzstan: the World Bank sheep development project and the new UK Department for International Development project "Support to livelihoods in livestock producing communities." Kazakhstan does not have any livestock development projects, despite the importance of rangelands as a national resource, the tradition of extensive livestock rearing, and the contribution of livestock to rural household economies. This project proposes measures for assisting producers, researchers and the commercial sector to realize greater value from wools and fibers through the market. These measures could be implemented through government and donor-assisted projects in the future.

Contributions to U.S. Agriculture. Information from this project could be used to determine to what extent the U.S. small stock, wool, and cashmere industries could become interested in Central Asian livestock products and contribute to the Central Asian breeding stock.

Contributions to Host Country. The case of Mongolia demonstrates the possible benefits to the host countries of developing a successful wool and fiber market. Selling raw cashmere has become the major source of income for privatized herders in Mongolia and raw cashmere production has risen by 70%, propelled by a strong demand from China, the U.S., and Europe. The Mongolian government has encouraged direct foreign investment and new technology.

Linkages and Networking. This project is linked closely with the two other GL-CRSP projects for Central Asia. We have developed a plan for sharing and synthesis of data among projects.

Other Contributions

Support for Free Markets and Broad-Based Economic Growth. For the past decade in Kazakhstan and Kyrgyzstan, pastoralists have been disengaging from the state collective farms and establishing contact with new domestic markets for livestock. One of the most pressing questions for the future of the livestock industry in both countries is whether small flock owners will have the resources to continue as livestock keepers. Ecological location and market access are also crucial to the success of livestock enterprises in both countries.

Contributions to and Compliance with Mission Objectives. By increasing the livelihood strategies of Central Asian households, this project goes a long way towards addressing how these objectives might be met.

Concern for Individuals. Throughout this project, we have been concerned about individuals and a household's ability to increase its economic base.

Support for Democracy. The fact that the peoples of Kazakhstan and Kyrgyzstan have to engage in the open market will enhance their interaction with market economies, stimulating their movement toward democracy.

Leveraged Funds and Linked Projects

Macaulay Land Use Research Institute, U.K., 2001 - Desertification and Regeneration in Kazakhstan and Turkmenistan: Modeling the impacts of market reforms on Central Asian rangelands. (DARCA) EU.

Training

CSU hosted a two-week training session in February 2003 for host country scientists Nurlan Malmakov and Aidos Smailov, and the project consultant, Carol Kerven. In addition, numerous people have been trained, both in Kazakhstan and Kyrgyzstan, on survey techniques and informal interviewing techniques.

Collaborating Personnel

United States of America

Dr. Michael Lacy, Professor, Sociology Department, Colorado State University.

Kazakhstan

Dr. Serik Aryngaziev, Head, Department of Goat Selection and Breeding, Kazakh Technological Research Institute of Sheep Breeding.

Dr. Koishybek Karymsadov, Head, Laboratory of Wool Quality Analysis, Kazakh

Technological Research Institute of Sheep Breeding.

Dr. Bolatkhan Makhatov, Director, Kazakh Technological Research Institute of Sheep Breeding.

Professor Terentiev, Researcher, Wool Standardization Lab, Kazakh Technological Research Institute of Sheep Breeding.

Kyrgyzstan

Dr. Irik Almeev, Head, Goat Breeding Department, Kyrgyz Research Institute of Sheep Breeding.

Dr. Abdugani, Goat Breeding Department, Kyrgyz Research Institute of Sheep Breeding.

United Kingdom

Dr. Carol Kerven, Independent Researcher, Macaulay Institute.

Collaborating Institutions

Kazakh Technological Research Institute of Sheep Breeding
Mynbaeva Village
Dhambul Rayon
Almaty Oblast, 483174
Kazakhstan

Kyrgyz Livestock Research Institute
Frunze Village
Sokuluksky Rayon
Chu Oblast, 722125
Kyrgyz Republic

Publications

Kerven, C., Aryngaziev, S., Davidson, G., Franchois, L., Malmakov, N., Mathijs, E., Wright, I.A. Goats and sheep in private flocks of post-Soviet Kazakhstan. Small Ruminant Research. In review October 2003.

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Kerven, C. 2002. Cashmere production in Kazakhstan and Kyrgyzstan. Paper presented at the Global Livestock CRSP Program Conference, Washington, D.C. October 9-12.

Principal Investigators

Lead Principal Investigator. Kathleen Galvin, Senior Research Scientist, Natural Resource Ecology Laboratory; Professor and Chair, Department of Anthropology, Colorado State University. Phone: 970-491-1642; Fax: 970-491-1965; Email: Kathy@nrel. colostate.edu.

Co-Principal Investigator. Nurlan Malmakov, Head of Reproductive Laboratory, Kazakh Research Institute of Sheep Breeding, Almaty Oblast, Kazakhstan.

Co-Principal Investigator. Irik Abdullavevich Almeev, Head of Goat Breeding Department Kyrgyz, Livestock Research Institute, Chu Oblast, Kyrgyzstan.

Improving Wool Marketing Through Wool Pools in Kazakhstan and Kyrgystan

Narrative Summary

After the breakdown of collective farms and the privatization of livestock, household sheep production became a significant source of livelihood for the Kazakh and Kyrgyz rural population. Sheep production helps Kazakh and Kyrgyz families to subsist in rural areas with few alternative employment opportunities. The rural population raises sheep for food and as a source of cash to purchase clothing and household items.

While the production and sale of sheep products represent an important source of income for the rural population, the current wool-marketing infrastructure is inefficient and underdeveloped, which contributes to producers receiving prices below world market levels. Constraints in the Kazakh wool market exist at several levels. The sheep farmers are not trained in handling and sorting their wool. This lowers the quality and price of their product. The farmers also lack objective information about the grade of wool they produce and have a limited knowledge about wool markets, marketing options, and the needs of wool buyers. The wool market is dominated by middlemen who are also untrained in wool sorting and handling. The middlemen often buy unsorted and ungraded wool from farmers and resell it for profit to larger buyers. These buyers resell the wool to end buyers who scour it and export it to China or Russia. Producers sacrifice value to the layers of intermediaries that separate them from the final buyers, and lack information about the wool they sell.

Wool marketing is further compromised by the lack of a full-service fiber lab in Kazakhstan. None of the existing laboratories in Kazakhstan have reliable, modern equipment that would allow for testing according to international standards. As a result, nowhere during the marketing process is the wool objectively tested and none of the market participants have objective information about the fiber products they produce or trade in. Each wool bale contains a variety of different wool grades and wool prices are relatively undifferentiated, reflecting the lack of product information and sorting. This penalizes especially those farmers who produce fine wools and are paid the same price as farmers who produce medium wools. The Kazakh end wool buyers who sell wool to China and Russia also lack objective information about the wool they buy and sell. This weakens their bargaining position vis-à-vis foreign buyers and prevents them from differentiating payments to producers.

The objective of this project was to research the existing situation in wool production and marketing in Kazakhstan and Kyrgyzstan and propose improvements in marketing infrastructure for different types of producers and buyers. The project team identified the following potential improvements in the wool marketing process: 1) collecting information on producers and wools harvested in the pilot region, including wool samples, and creating a database on wool and cashmere production in the pilot region

that could develop into a country-level database; 2) training large sheep farmers and wool buyers in wool sorting and handling at the farm; 3) setting up alternative marketing organizations, such as wool pools for small farmers; 4) working with wool buyers to set up as fiber lab in Kazakhstan; and 5) working with the Kyrgyz Sheep Producers Association to organize testing of Kazakh wool at their fiber lab. This report examines these activities and progress made.

Research

Activity One: Research on Wool Production and Marketing in Kazakhstan and Kyrgyzstan

Problem Statement. The researchers will conduct a survey of households and sheep farms and interview producers, traders, buyers, and processors. The research will examine the commodity (types of wool produced), the main actors involved in production and marketing (wool producers, traders, buyers and processors), institutions and facilities (producer associations, wool warehouses, shearing, grading, packing and processing facilities, fiber-testing laboratories), production and marketing processes (wool production, collection, handling, sales and processing), and markets for Kazakh wool. The team will focus on describing the relationships between the wool market participants and evaluate the different bargaining capacities, needs and problems of the producers, traders, and buyers. It will also focus on identifying the problems of small wool producers.

The team will evaluate the facilities for wool sorting, grading, measuring, and packaging available in the area. This would include measuring and fiber testing equipment, sorting and packaging facilities, wool warehouses, pools, and processing facilities. The team will assess the level of skill to sort and grade wool on the part of the producers and traders, and the availability of information about prices and markets for different grades of wool.

The team will collect wool samples from farmers and households, test them in a U.S. laboratory, and generate estimates regarding the amounts of wool of specific grades produced by farmers and population in the pilot region. The project will explore markets and marketing options, both foreign and domestic, for the different grades and quantities of wool produced in the pilot regions.

This information will allow us to develop a model of the current wool production and marketing processes. The team will use the data to document the movement of wool from the producers to the buyers and processors, identifying specific problems at different levels of this process. It will be used to create a data-bank about the local sheep and wool producers, their marketing practices, and the quantities and qualities of wool produced.

Progress. Liba Brent and Koyshibek Karymsakov completed 40 surveys of sheep farmers, ten surveys of wool buyers, and five surveys of local administrators and veterinary inspectors between June 6 - September 30, 2003. The survey data covers the key aspects of wool production and marketing in the pilot regions (Almaty and Taldy Korgan oblasts). The data helps to identify problems in the marketing process and outline possible solutions.

In the course of the fieldwork, the team established contacts with wool producers in the Almaty and Taldy Korgan oblasts, and with major Kazakh wool buyers based in Almaty. Interviews with producers and buyers helped

us to identify their specific needs and concerns. These contacts will allow us to collaborate on improving the wool-marketing process in the course of the three-year project that begins in October 2003, "Developing Institutions and Capacity for Wool Marketing in Central Asia," in collaboration with University of Wyoming and Colorado State University.

Based on interviews with the market participants, the team uncovered the following weaknesses in wool marketing:

1) Poor handling and preparation of wool, lack of sorting and grading by farmers and buyers. Kazakh sheep farmers, many of whom are new to wool marketing, have little or no training in the handling and preparation of wool. They do not separate tags and bellies from the fleece and have little experience in wool grading and pricing. The middlemen who purchase wool from farmers are seasonal workers, often equally inexperienced in assessing fiber quality and in sorting wool. They bale together various grades of dirty and clean wool which lowers the price of all wools in the bale. As a result of these deficiencies, high-quality fine wools are sold for less than world market value.

2) Lack of information and market incentives for farmers to improve wool quality. Because of the lack of objective fiber testing, farmers cannot obtain information about the grade and quality of their wool. They do not know world market prices and are uninformed about the needs of wool processors in wools with specific parameters. This lack of information prevents them from making informed breeding decisions and places them in a weak bargaining position vis-à-vis wool-buyers. Given that fine wool is often not separated and priced higher than medium wool, farmers lack the incentive to improve wool quality and breed for wool.

3) Poor organization of wool collection and delivery to markets. Wool is collected by local middlemen who resell it to larger buyers. The larger buyers located in regional centers resell it again until the wool is sold to Chinese or Russian processors. The producers are hurt by supporting several middlemen and receiving a considerably lower price than if they sold wool directly to larger buyers. The producers are unfamiliar with alternative marketing options such as wool pools that are widely used by producers in the United States. Wool pools and marketing cooperatives allow small farmers to create economies of scale in wool marketing, increase their control over the marketing process, and obtain higher prices.

4) Lack of wool sampling and objective measurement of wool quality. Nowhere during the process of wool collection and marketing is the wool correctly sorted, graded, and tested. Consequently, none of the involved parties has objective information about the quality of the wool they produce or trade in. This makes it impossible to price the wool based on current world market prices. The Kazakh producers and buyers are at a disadvantage vis-à-vis their foreign competitors who sell graded and professionally tested wool for a market price.

5) Outdated fiber laboratories. Kazakh wool is not sampled and objectively tested due in part to the lack of fiber laboratories in Kazakhstan. The existing laboratories have outdated equipment and lack trained personnel.

Based on these findings, the team initiated the following solutions:

1) Training in wool handling, sorting, and marketing will be organized together with major Kazakh wool buyers. During her fieldwork in the summer of 2003, Liba Brent and the directors of major Kazakh wool buying companies discussed the possibility of

training farmers in handling and sorting wool. Directors of three major Kazakh wool buying companies (Asutor, Archar Vul, and ATA) expressed interest in collaborating with our team to organize training in standard wool sorting and handling for producers in the Almaty and Taldy Korgan regions during the 2004 wool season. Liba Brent will travel to Kazakhstan in December 2003 to further discuss and coordinate the training program.

2) Helping to differentiate payments for different grades of wool to give incentives to farmers to produce quality wool. The team discussed the need for improved wool handling and sorting with sheep farmers in the pilot areas. Several large sheep producers agreed to participate in the training program on wool handling and grading during the next wool season in the spring of 2004. Improvement in wool handling and sorting will allow farmers to demand a higher price for sorted, clean wool. Higher prices should give farmers the incentive to produce higher quality fiber and select for wool during sheep breeding.

3) Improving producers' position vis-à-vis intermediary wool buyers. Producers can potentially benefit through improving the organizational structure of wool marketing. The team discussed the possibilities of joint wool marketing with household producers and small and medium farmers in the pilot regions. We also discussed with larger farmers the possibility to sell sorted and graded wool directly to final buyers by improving advertising and establishing direct contacts with buyers. Some farmers agreed to take steps towards collecting wool together with their neighbors during the next season and trying to market a larger lot of sorted wool directly to larger buyers.

4) Collecting data on sheep producers in pilot regions. The team began to collect information on wool production and sheep farms in the two pilot regions. Farms that have over 300 sheep are being located and marked on a large-scale map of each region (scale 1:200,000). The information collected includes the name of the farmer and the numbers and breeds of sheep produced. This information will be entered into a database and distributed to wool buyers, with the goal of assembling larger lots of similar wool. The database will be updated and expanded in the course of the three-year project. It will include data on wool produced at the farms after the collection of samples and their testing using OFDA 2000 (Optical-Based Fiber Diameter Analyzer).

5) Improving testing of Kazakh wool. Producers and buyers need to become better informed about the product they produce and sell. This can be accomplished through the collection of wool samples from farmers and buyers and objective testing of these samples using reliable equipment. In order to promote fiber testing and learn about wool produced in the pilot regions, the team collected wool samples from farmers and wool buyers in the summer of 2003. These samples were analyzed in Kyrgyzstan using OFDA 2000, owned by the Kyrgyz Sheep Producers Association. The results of these tests, discussed under Activity Four, will be distributed to wool producers and buyers in December 2003. Producers and buyers will be informed about the results of these tests and encouraged to continue collecting wool samples, testing their wool, and actively using the acquired data to make production and marketing decisions. The team will work with wool producers and buyers to collect samples of wool during the next season and analyze these samples using the services of Kyrgyz Sheep Breeders Association (KSBA) in Kyrgyzstan. Liba Brent worked with the engineering team of the wool processing plant

Kargaly near Almaty to produce wool-sampling tools that will be distributed to farmers and wool buyers during the spring wool season.

6) Examining the potential of setting up a fiber lab in Kazakhstan. The fiber laboratories in Kazakhstan lack equipment and trained personnel. The team discussed the possibility of forming an independent fiber lab with the Kazakh wool buyers.

The most sophisticated fiber lab in the region was set up by the KSBA with the assistance of the World Bank. The World Bank-funded Sheep Development Project purchased two OFDA 2000s for KSBA. Liba Brent introduced the Kazakh wool buyers to the leadership of the Kyrgyz Sheep Breeders Association (KSBA) and arranged for their visit of the KSBA's fiber lab. Kazakh wool buyers are now using the testing services of KSBA until they can establish their own laboratory in Kazakhstan. A successful collaboration between the Asutor wool buying company and KSBA has been established. Asutor and other wool buyers are currently testing wool samples in Kyrgyzstan.

Activity Two: The Collection of Information on U.S. Wool Production and Marketing with a Focus on Market Institutions (Wool Pools, Wool Warehouses, Sorting and Grading Processes) Used by U.S. Wool Farmers

Problem Statement. Compared to Kazakh or Kyrgyz producers, American small sheep producers benefit from developed market infrastructure such as wool pools and a grading system. American wool producers solve the problems of small-scale wool production by pooling wool into wool pools or warehouses to achieve economies of scale and to obtain higher prices for wool. Marketing wool through wool pools has advantages for both buyers and sellers. Pooling wool permits producers to increase the amount of various kinds of wool and sort and combine the wool into lots based on fiber diameter, white-face, black-face, length, etc. By combining wool into larger lots, grading it, and marketing it through the wool pool, sellers increase their bargaining power and chances to find a buyer. The wool pools also allow for the producers to share the cost of baling and transporting wool to a buyer be it a mill or a middleman. Without sharing such costs and using services of the wool pool, it would be difficult for the American producers to realize a profit from wool, especially during the worldwide decline in wool prices of the late 1990s.

Information on sorting and grading practices and institutions, such as the wool pools used by American sheep producers, will be assembled in a format that can be presented as educational material to Kazakh sheep farmers. The Thomas-Brent team will collect data and information on American wool pools and grading systems. Brent plans to visit wool pools, collect information about pooling, sorting, grading and marketing practices, and videotape the wool pool. The edited video and other educational materials will be used to inform the Kazakh wool farmers about production, sorting, grading, pooling, and marketing practices of U.S. wool farmers, and the effects of these technologies and practices on the marketability of U.S. wool.

Progress. Liba Brent visited two wool pools in the summer and fall of 2002, one in Maryland and one in Montana. She videotaped the pools, interviewed the organizers and the sheep farmers, and collected information about wool handling, sorting, baling, and marketing. She also visited the Yocom McColl fiber laboratory in Denver,

Colorado and a wool processing lab at the University of Wyoming at Laramie. She videotaped the Yocom McColl laboratory and the processing facilities at Laramie and collected information on standard wool testing methods in the United States.

Brent produced an hour-long educational video on American wool pools and the fiber-testing laboratory in Denver in 2003. The video was narrated in Russian and shown to farmers and wool buyers in Almaty and Taldy Korgan regions in the summer of 2003. It showed the sheep farmers new methods of joint wool marketing and introduced them to a better organized marketing and grading system. It also stressed the importance of wool sample collection and standard testing.

The video was effective as an educational material and inspired the discussion of improving wool marketing in Kazakhstan among producers and buyers. The Kazakh sheep farmers were very interested in seeing how American farmers market their wool and were more open to share information about sheep production after watching the video. They felt the project is reciprocal by not simply gathering data about wool marketing in Kazakhstan, but also offering a view of the American system. Kazakh wool buyers benefited from seeing the video on the Yocom McColl fiber-testing laboratory in Denver. They are interested in setting up an independent fiber lab in Almaty and need to know how such laboratories operate and maintain international testing standards. The video will be shown to farmers and wool buyers during training seminars and meetings that are on the agenda of the upcoming three-year project.

Activity Three: Educational Seminar

Problem Statement. The Central Asian farmers lack information about wool markets and the needs of wool buyers and processors. They also lack cooperative marketing institutions that can generate economies of scale in sorting, grading, baling, and marketing and increase wool prices for small producers. The project plans to organize a seminar to inform and educate sheep producers about grading and marketing practices used by U.S. sheep farmers to improve the marketability of their wool, and explore the capacities and constraints for introducing similar practices in Kazakhstan and Kyrgyzstan.

The seminar will cover the following topics: 1) a general overview of the world wool market, recent market changes, and their impact on farmers in the U.S. and Kazakhstan; 2) information on domestic and foreign markets for different grades of wool produced in the pilot area, prices and terms offered by the potential buyers; 3) information on different wool marketing strategies used by U.S. sheep farmers and their advantages and disadvantages, including the video of the wool pools; 4) training in grading and sorting of wool; and 5) discussion of strategies for improvement of wool production and marketing in the pilot regions, including the potential development of wool pools. The team will document the process of organizing the seminar and evaluate its effectiveness.

Progress. Liba Brent and Koishibek Karymsakov met with sheep farmers in June and July of 2003 and organized small meetings of farmers in both regions. These meetings helped to familiarize the farmers with the agenda of the project and discuss collaboration on sorting and grading wool during the spring of 2004. However, the larger meeting planned in the Almaty region did not take place as a result of the interference of local administration that could not decide the date and the location. The team decided to postpone the meeting until December of 2003. The project received a no-cost extension.

During this time period Liba Brent will travel to Kazakhstan and organize a meeting for sheep farmers and wool buyers in the Almaty region in December 2004.

Activity Four: Analysis of Survey Data on Wool Production in Kazakhstan, Proposal of New Models that Would Enhance the Production and Marketing Capacity of Small Producers, and Evaluation of the Possibility to Introduce Organizational/ Institutional Technologies and Structures Used by U.S. Wool Farmers in Kazakhstan

Problem Statement. The team will analyze the data collected in Kazakhstan and propose specific improvements at the different levels of the wool production and marketing process. It will focus on identifying means of improving the wool production and marketing capacity of Kazakh sheep farmers and households. The possibility of creating wool pools and a grading system based on the U.S. model will be examined. The researchers will explore markets and marketing options, both foreign and domestic, for the different grades and quantities of wool produced in the pilot region. They will identify improvements in production and marketing that are needed to increase the exportability of Kazakh wool. The proposals will be presented to wool producers and other market participants and the regional and federal governments.

Progress. Data on 40 sheep producers including households (16-50 sheep), small producers (100-270 sheep), medium producers (300-600 sheep), and large farms (700-2,000 sheep) was collected during fieldwork in the summer of 2003 in the Almaty and Taldy Korgan region. In addition, 320 wool samples were collected from farmers and buyers in the Taldy Korgan and Almaty region. The samples were analyzed using OFDA 2000 at the fiber lab of the Kyrgyz Sheep Producers Association in Bishkek, Kyrgyzstan. The survey analysis offers the following insights:

1. Sheep Breeding is profitable and essential for subsistence and commerce of the rural population. 39 out of 40 sheep farmers and households interviewed claimed sheep production was profitable. Although most farmers do not do budget accounting, several farmers estimated their profit from one sheep to be anywhere from 400 to 800 tenge (USD $2.80 to $5.60). However, regardless of the level of profitability, sheep breeding is important for all households and farmers as a source of food and income. Based on the survey data, a four-person family needs to maintain at the minimum 50 sheep and 2-3 cows to maintain subsistence. Families that have fewer animals live in poverty. An average 4-person family consumes as least one sheep per month and sells 1-2 sheep throughout the year to generate cash and purchase clothes and household items. Most households and farmers expressed an interest in increasing their flock and none considered selling the sheep and the farm. The number of sheep increased at most farms since last year. These trends point towards sheep breeding as an important means of livelihood for the rural population. Improvements in production and marketing of sheep products are essential for the commercial development of sheep breeding. Such improvements can help sheep breeding families to move beyond mere subsistence.

2. Sheep Breeding in the village and on the farm. In Kazakhstan, two distinct sheep breeding contexts can be identified. One includes village households, most of which have anywhere from five to 50 sheep. The households take turns grazing their sheep on common pastures surrounding the village and stall them in their yards overnight. Most

households do not own pastures or large sheep pens and are unable to increase their flock and develop sheep breeding as a commercial enterprise. Rather, they produce food and generate income through a variety of other activities besides sheep breeding such as the sale of milk and other agricultural products. They use their sheep primarily for food and occasionally sell one or two for money. The sheep produced by households are usually of mixed breed (Kazakh Fat Rump and Kazakh Fine Wool mix), producing medium or coarse wool. It is difficult for household producers to maintain a pure breed because their sheep graze together with others and not all of them castrate their rams. In terms of improving marketing infrastructure for wool as well as cashmere and angora fibers, the village households could benefit from joint marketing through organizations such as wool pools that would allow them to generate economies of scale and adopt standard wool handling and sorting practices. The research team discussed the possibility of organizing a wool pool in the Akterek village during the next wool season.

The second context of sheep production is the sheep farm. Sheep farms are located outside of the village. The farmers raise several hundred sheep and about half of them migrate between summer and winter pastures. Out of 24 farmers who answered the question on migration, 12 migrate between pastures, six would like to migrate but do not have the opportunity because of the lack of pastures or resources, and six are not interested in migrating because their pastures are satisfactory year-round. The sheep farms are located further from the villages and markets, but many have favorable conditions for the development of commercial sheep production. The farmers are able to perform selection and choose specific breeds based on preferred characteristics. According to the survey data, the majority of farmers are producing mixed breeds of sheep but many are interested in developing a specific breed after they accumulate resources to buy purebred animals and introduce artificial insemination. In the context of the project, is important to work especially with those farmers who are interested in wool production and wool or dual-purpose breeds of sheep. The project plans to collaborate with several large farmers (500+ sheep) during the spring 2004 season to collect and test wool samples, improve wool sorting and handling, and develop direct connections with wool buyers.

3. Decline in purebred sheep and in Kazakh Fine Wool Sheep. About 90% of farms and households surveyed have mixed breeds of sheep. While during the Soviet period there was a focus on wool and wool breeds to satisfy the need for wool on the Russian market, most village households and farmers currently produce mixed breeds. The most common is the hybrid of Kazakh Fine Wool (KF) and Kazakh Fat Rump Sheep (KFR) that produces medium wool. Farmers and households often prefer mixed breeds or KFR to purebred KF. They argue that KFR lambs and lambs of mixed breeds are stronger and healthier than KF lambs and require less care during lambing. The ewes do not need to be stalled and the KFR lambs are mobile and able to graze on their own several days earlier than the KF lambs. KFR lambs are born with a wool coat which protects them against cold. KF lambs are born without a coat and need to be kept in warm pens. However, some farmers claim that the KF ewes give more twins than KFR ewes.

The choice of a breed does not depend strictly on costs and benefits calculations, but on the local sheep breeding history. In some areas people prefer KF because it was the

breed produced in the local sovkhoz during the Soviet period. Farmers and households obtained this sheep breed during privatization and prefer it because they have been accustomed to working with it in the past. Knowledge of a particular breed is valuable for making the appropriate production decisions. However, in most cases the farmers crossed the local purebred sheep with other breeds, primarily the KFR sheep. Based on the survey results, farmers in the Almaty area produce primarily KF and KFR breeds and crosses. Farmers in the Taldy Korgan region produce Hemshire, Finish Landais and KFR breeds and crosses. The increase of mixed breeds is an outcome of several factors:

1. The farmers try to produce sheep that require a minimal investment in winter feed, sheep pens, and medicine and that can graze all year with minimum extra feeding. Most farmers and households feed sheep only for a brief period during lambing or in winter, during a heavy snowfall. The native KFR sheep are better adapted to these conditions than KF sheep and thus are less costly to maintain.
2. The KFR sheep and mixed breeds are often slightly larger and heavier than the KF sheep and give more meat.
3. The global wool prices have been low with the exception of the last two years. In addition, the Kazakh wool market discriminates against fine wool as a result of poor handling, sorting, and testing. Consequently, the sales of fine wool produced by KF sheep did not pay off.
4. There has been a decline in breeding services and purebred animals. Farmers who want to develop fine wool sheep and other breeds have difficulties finding the appropriate breeding stock.
5. Village households, which are the most numerous sheep production units in Kazakhstan and cumulatively produce more sheep than specialized sheep farmers, graze sheep together and produce mixed breeds. Household producers who produce only a few sheep mostly for family consumption are not interested in maintaining a specific breed.
6. Most households and small farmers have been focused on producing for subsistence because the price of sheep and sheep products has been depressed until recently. The farmers are only beginning to make commercial and business decisions related to sheep production, including breeding and selection. Only recently have they been able to accumulate enough surplus to sustain or increase their flock.

4. Prices of Meat in 2003. The price of one-year old lamb was around 10,000 tenge (USD $70) in the summer of 2003. The price of a five- to six-month old lamb was around 6,000 tenge (USD $42). The price increased by about 1,000 tenge, or USD $7, since last year. Producers have been able to produce surplus as a result of the price increases (i.e., they need to sell fewer sheep to purchase goods and maintain their families) and are recognizing sheep production as a viable means of livelihood. As a result, sheep production in Kazakhstan began to grow. Most sheep farmers take their animals to the market for sale only when they need money and do not work with slaughterhouses and meat processors on the basis of contracts. They try to sell only old ewes and five-month or one-year-old rams to maintain or increase their flock.

5. Prices of Wool in 2003. The price of wool varied considerably and did not always accurately reflect the wool grade. The average price of fine wool paid to surveyed households and farmers was 160 tenge/kg (USD $1.1) while last year's price was 100 tenge/kg (USD $0.70). This means that the price of fine wool increased

by 37.5% since last year. The price of medium wool was 107 tenge/kg (USD $0.74), compared to 80 tenge/kg (USD $0.56) a year ago—an increase of 25%. The price of coarse wool was 25 tenge/kg (USD $0.17), while last year coarse wool was virtually unsellable.

Based on these prices, a single ewe produces an annual revenue of $70 (the sale price of one-year-old lamb) or $42 (sale price of a 5-6 month old lamb) and $3.30 in wool (3 kg. of wool at USD $1.1) for fine wool sheep. A flock of 100 sheep can generate about USD $2,500 in revenue from meat (100 lambs, 50 ewes used to replace old ewes, 15 rams consumed, 35 rams sold @ USD $70 each), and about $300 in wool. Thus, wool brings about 11% of revenue from sheep production.

Based on sampling fine wool bales at several locations in Kazakhstan, the average fiber diameter of this wool was 23 micron. However, Kazakh farmers received a considerably lower price for this wool than offered at Australian auctions where 23 micron clean wool sold for USD $7.1 in auctions in August 2003. At 50% yield and USD $0.40 cent/kg. cleaning cost, 1 kg. of 23 micron dirty wool sold for about USD $3.15. Under the assumption that the sorting and baling of wool costs USD $1 per kg. in Kazakhstan, and the cost of transporting wool to China is relatively low, under improved marketing conditions the farmers could target to obtain around USD $2 per kg of dirty wool, or twice as much as they were offered. However, given the lack of proper sorting, grading and testing, Kazakh sheep farmers do not know what grade of wool they produce and are uninformed about world market prices. International wool buyers are in turn uninformed about the Kazakh wool market and wool grades produced. The project proposes to work on improving wool sorting and handling with several sheep farmers, test their wool and help them make connections to wool-buyers who offer better prices. The project will work on creating a database on wool grades produced by different farms to increase product information and facilitate wool trade in the pilot region.

6. Results of Wool Sampling Tests. The team collected 320 samples of "fine" wool from wool buyers in the Taldy Korgan and Almaty regions. The samples were analyzed at the laboratory of the Kyrgyz Sheep Breeders Association using OFDA 2000.

The 80 samples of "fine" wool collected from buyers in Taldy Korgan showed an average fiber diameter of 23.29 micron. The fiber diameter ranged from 20.6 micron to 26.3 microns, with standard deviation of 4.9.

The 120 samples collected in the Almaty oblast showed an average fiber diameter of 23.6 micron, standard deviation of 4.9. The finest samples were 21.5 micron and the coarsest samples were 26.3 micron.

Another 90 samples analyzed were collected by the Semteks company. The average fiber diameter was 23 micron, with 20.7 as the finest fiber and 25.7 as the coarsest, and standard deviation of 4.9.

30 samples collected by the ATA wool buying company showed average micron of 23.2, with the smallest value of 21.5 and maximum value of 24.7, standard deviation of 4.4.

The average fiber diameter of all samples collected was 23.27 micron.

The average standard deviation was 4.8, and the fiber diameter ranged from 20.6 micron to 26.3 micron. The large variability of fibers in the sampled bales represents the potential for price improvements from sorting and grading of wool. More precise information about each lot would help to offer specific grades of wool for specific market prices. The team incorporated training in the sorting and grading of wool and sample

collection and testing in the program of the three-year project "Developing Institutions and Capacity for Sheep and Fiber Marketing in Central Asia." In addition, ongoing sample collection and testing is important to increase information about the grades of wool currently produced in specific regions and on specific farms in Kazakhstan.

Gender

The project seeks to show Central Asian producers that sheep breeding and wool marketing is done by women as well as men in the United States. The video on U.S. wool pools showed that American women take an active part in sheep production—the video has shown that the majority of wool producers who delivered wool to the pool were women. The case of American women sheep breeders provided an example for Central Asian women to expand beyond their traditional roles in livestock production and in the household economy. Women in the households of sheep producers were invited to participate in the seminars and discussions on wool marketing. Although the team made an attempt to include women in the survey of sheep producers, it became clear that women were often much more poorly informed about sheep production than men. For this reason the team had to rely primarily on male informants.

The team plans to train women as wool sorters and graders during the 2004 wool season and continue to explore opportunities to expand the role of women in wool handling and marketing.

Policy

Policymakers at the Rural Administration Centers of the Almaty and Taldy Korgan regions were informed about the objectives and activities of the project and invited to participate in the seminar for sheep producers. The possibilities of improving marketing institutions were discussed with the local policymakers.

Outreach

The team developed close contacts with sheep producers, buyers, and local administrators. Liba Brent spent two months in Kazakhstan and Kyrgyzstan in the summer of 2003 visiting producers and wool buyers and promoting communication and collaboration among all parties involved in the wool production and marketing process. These contacts will be essential for ensuring a successful accomplishment of the project objectives.

Developmental Impact

The objective of the project is to promote the sustainability of small-scale sheep production by sharing information and testing methods to increase income from wool. With an increased income from their product, producers will be better able to sustain their livelihoods through family and community-based sheep production.

U.S. agricultural expertise was featured by the project. The demonstrational video of U.S. wool pools highlighted U.S. producers and promoted farmer-to-farmer contact which offers opportunities for American participation in providing testing equipment, genetic resources, and commercial services. American sheep producers also learned about sheep production in Central Asia. During 2002 Liba Brent produced a documentary video on sheep production in Kazakhstan. A copy of the video was given to the Northern Montana Wool Pool and shown at a conference of Montana sheep producers.

The host country benefited by learning about new methods of wool grading and marketing. Wool producers learned about new methods of wool handling and about marketing organizations such as wool pools. Producers and buyers become better informed about the advantages of improving wool sorting, grading, and testing standards that can increase their access to world markets and prices.

The project created a linkage between U.S. and Central Asian sheep producers through the exchange of video data and other information, and investigated the possibility of institutional transfer (i.e., transfer of wool pools and grading system from the U.S. to Central Asia). The project also contributed to strengthening the linkage between Central Asian wool producers and domestic and foreign wool markets.

The project was also linked with two other small grant projects, led by Kathy Galvin of Colorado State University and Malcolm Childress of the University of Wisconsin, that focus on different aspects of fiber production and marketing. The projects collaborated by sharing data and information and by preparing to conduct future research on a broader scale.

The project coordinated with the International Centre for Agricultural Research in the Dry Areas (ICARDA), which is currently conducting related survey research on sheep and wool in Kazakhstan and Kyrgyzstan and is concerned with improving markets for livestock products in the region. Dave Thomas and Liba Brent met with ICARDA representatives in Madison, Wisconsin in November 2002 and discussed possible avenues of collaboration.

Other Contributions

The project directly focused on the development of markets and market institutions. It was concerned with broad-based economic growth by focusing on market constraints for small producers and households that constitute the majority of rural population in Central Asia.

In compliance with the USAID Mission objectives, the project supported the development of markets and private enterprise and promoted grass-root development of civil society institutions.

The project supported a pro-democratic process and development of civil society by facilitating the development of grass-roots organizations of producers, such as wool pools. Local wool marketing institutions such as wool pools could empower small sheep producers to collaborate on improving sheep production and market access and facilitating the development of communities of sheep producers that can become an active voice of civil society in the rural areas.

Leveraged Funds and Linked Projects

The project is linked with GL-CRSP small grant projects led by Kathy Galvin and Malcolm Childress. The small grant project has not attempted to leverage funds. The project is also intended to serve as a first phase in a larger program proposed for the 2003-2006 by a consortium of CRSP researchers titled "Developing Institutions and Capacity for Sheep and Wool Marketing in Central Asia."

Collaborating Personnel

United States of America

David Thomas, University of Wisconsin-Madison, Department of Animal Science.

Liba Brent, University of Wisconsin-Madison, Department of Sociology.

Malcolm Childress, University of Wisconsin-Madison, Land Tenure Center.

Kathy Galvin, Colorado State University, Human Ecology Laboratory and Department of Anthropology.
Carol Kerven, Macaulay Institute.
Robert Stobart, University of Wyoming, Department of Animal Science.

Kazakhstan
Nurlan Malmakov, Kazakh Research Technological Institute of Sheep Breeding.
Koyshybek Karymsakov, Kazakh Research Technological Institute of Sheep Breeding.
Murat Otynshiev, Asutor, Wool buying company.

Kyrgyzstan
Akylbek Rakaev, Kyrgyz Sheep Producers Association.

Collaborating Institutions

University of Wisconsin-Madison
438 Animal Science Building
1675 Observatory Drive
Madison, WI 53706-1284

Kazakh Technological Research Institute of Sheep Breeding (KTRISB)
Mynbaevo Village, Djambulsky Raion
Almaty Oblast, 483174 Kazakhstan
Phone: 73-2770-64120

Abstracts and Presentations

Brent, Liba. 2003. Wool Marketing in Montana and Maryland. Video presented to farmers and wool buyers in Kazakhstan and Kyrgyzstan.

Principal Investigators

Lead Principal Investigator. David Thomas, University of Wisconsin-Madison, Dept. of Animal Sciences, Madison, WI 53706. Phone: 608-263-4306; Fax: 608-263-5157; Email: dlthomas@facstaff.wisc.edu.

U.S. Co-Investigator. Liba Brent, University of Wisconsin-Madison.

Host Country Co-Investigators. Nurlan Malmakov, Kazakh Technological Research Institute of Sheep Breeding; Koyshybek Karymsakov, Kazakh Technological Research Institute of Sheep Breeding.

Co-Benefits of Grassland Regeneration of Abandoned Wheat Areas for Carbon Sequestration, Livestock Productivity, Biological Conservation, and Socio-Economic Development

Narrative Summary

Carbon sequestration of grasslands and abandoned farmlands in Kazakhstan has the potential to offset the global increase in atmospheric CO_2 levels caused by fossil fuel emissions. The analysis of different land use management options suitable for this region of the world will provide a set of management options for improving the natural resources and economic conditions on which people rely. This project evaluated how recovery of abandoned croplands and changes in the seasonal grazing mobility of livestock in the Kostanai steppe region of northwest Kazakhstan affect carbon sequestration, vegetation composition, and rangeland productivity. Field studies and surveys suggest that investment in agricultural management needs to be developed to promote re-adoption of seasonally mobile grazing systems. This re-adoption is likely to lead to increased carbon storage, sustainable rangeland use, reduction of household poverty, and conservation of biodiversity.

Kostanai Oblast is situated to the east of the Ural Mountains and extends 800 km. from north to south and 400 km. from west to east. Most of Kostanai Oblast is in the zone of unstable climatic conditions and droughts, with a short growing season and sandy to stony soils, which contribute to the variable cropland yield and rangeland productivity. Much of the rich cool-season steppe ecosystems on richer soils have been ploughed and only a few remnants remain. In 1991, the cultivated area of the oblast was approximately 278,000 ha. The state farms had 48,000 heads of cattle and more than 175,000 heads of sheep. During the past ten years, agricultural land use and production have declined dramatically. The amount of arable land estimated in 2000 was less than half of what was estimated in 1991, with approximately 120,000 ha. of cultivated lands. The number of cattle in 2000 was approximately 15,000 and the sheep decreased to approximately 11,000 head. The majority of animals (over 90%) are now private property.

Since the collapse of state farms and the economic crisis of the early-mid 1990s, the number of sheep has declined greatly. Goat numbers are increasing due to their more rapid reproductive rates and the cessation of state farm prohibitions on keeping private goats in former sheep farms. Selling cattle to meat markets has become the main source of farmers' income from livestock. The cattle population has been more stable than the sheep population, a great deal of which was bartered away at very low exchange rates during the height of the economic crisis some eight years ago.

Senior government agricultural officials both at the provincial and districts levels have few plans or concepts of how to increase the stock of sheep in the study areas. One district official responsible for livestock commented that he had "nothing but a pen to help livestock farmers." New national and provincial agricultural programs are aimed at improving veterinary services, creating pedigree horse stud farms, and rehabilitating meat and skin processing factories in the urban areas.

There are no externally-funded development projects aimed at assisting the local population in the study areas. There are several international projects aimed at wildlife and ecosystem conservation. Local government officials at the district and village levels were very interested in discussing how the rural economy could be revitalized, and had many worthwhile suggestions. The perception of the local population is that their region is relatively neglected due to its remoteness from the more populated, grain growing areas of northern Kostanai.

Research

Introduction and Rationale. Conversion of grasslands into croplands and improper management of these croplands has caused a large amount of environmental damage (with soil carbon loss) in this part of the world. The amount of arable land has increased dramatically since the late 1950s, reaching 43 million hectares in Central Asia (8.67 million hectares of which are irrigated). The current estimate of cropland abandonment in the year 2000 is approximately 12.8 million hectares.

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 25-30% reduction of humus reserves due to cultivation (GL-CRSP 2000).

In 1991, the cultivated area was approximately 278,000 ha. This project evaluated how the recovery of abandoned croplands and changes in the seasonal grazing mobility of livestock in the Kostanai steppe region of northwest Kazakhstan affect vegetation composition, rangeland productivity, carbon sequestration, and economic stability. Field studies and surveys indicate that re-adoption of seasonally mobile grazing systems have beneficial effects on rangeland condition and the recovery of abandoned farmlands. This re-adoption is likely to lead to increased carbon storage, sustainable rangeland use, reduction of household poverty, and conservation of biodiversity. The following analysis indicates that investment guidelines should encourage nomadic grazing systems to meet these aims within this type of steppe ecosystem.

Regional Context. The land use systems of Kazakhstan and the surrounding Central Asian countries are diverse for temperate ecosystems, due to the fertile soils, mountain-fed rivers, and range of climate. The simultaneous occurrence of agricultural abandonment with the intensification of croplands and sedentarization of livestock and pasture exploitation presents a complex matrix of land cover dynamics radically different from what was historically a nomadic pastoral land use system.

Land distribution in the arid and semiarid regions of Central Asia is predominantly rangelands, with approximately 246 x 10^6 ha. in range and only about 43 x 10^6 ha. in croplands (UNDP 2002). More than 60% of land in the five Central Asian countries (Kazakhstan, Uzbekistan, Turkmenistan, Kyrgyzstan, and Tajikistan) is rangeland, amounting to some 246 million hectares (Kharin et. al. 1999). Half of this land receives less than 300 mm. precipitation per year. Arable lands are rather small in comparison, accounting for approximately 43 x 10^6 hectares.

The modifications of the socio-economic situation in the region have been a primary agent in the change of land use systems during the past century. During the early 1900s, collectivization of croplands and livestock systems was instigated throughout the region. These land use policies led to major changes

in land management throughout the region and altered the trans-human patterns of livestock and rangeland management. Large-scale intensification efforts took place during the Soviet era, with large tracts of land converted to cropland. Livestock production was made more sedentary and collectives for agricultural production were organized throughout the region. During the past decade, most of the land use management in these countries have had to adjust to new situations and have become transitional economies. These countries are among the most vulnerable in terms of their economic, political, and environmental systems. Interactions between and among policies, human responses, and earth system functions cannot be decoupled. Transition economies are characterized by a combination of volatile markets, policy reforms, and unclear and uncertain land tenure systems. It is not any single one of the factors, but rather the combination of all three, that makes these systems and peoples vulnerable in a number of different capacities.

Patterns of politically induced changes in demography are found in the Asian region of the former USSR. For example, as Russian dominance in this region increased during the 18th century, the Kazakh society was transformed from a nomadic to a more agrarian and industrial society. Currently, the population of Kazakhstan is approximately 17 million people, with 40% being Kazakh, 40% Russian, and the remaining 20% divided among some 100 different ethnic groups. Total population of the Central Asian countries has increased from 23 million in 1959 to almost 54 million in 1996 (Kharin et. al. 1999). By rough estimation, from 4 to 5 million people (mainly Russians) have emigrated from these countries since 1991 (Kharin et. al. 1999).

Recent changes in the physical climate and socio-economic factors in Kazakhstan (i.e., transition of the political-economic state following the dissolution of the USSR) have led to changes in land use decision-making in the region. These decisions have resulted in cropland abandonment, degradation of soils due to salinization and desertification, and damage to wetlands due to modifications of water regime and industrial development. Destocking of rangelands in the Central Asian region has been marked, especially in Kazakhstan in contrast to other pastoral countries across the world. Despite these changes, the productivity of agricultural, grassland, and non-forest ecosystems are still considered as potentially important food-producing regions.

These changes have resulted in the reduction of the numerous basic social services. Rural infrastructure supporting health care, education, drought reduction mechanisms, and water resource maintenance have all been reduced in much of the region. The resulting impacts have been increased hardship and poverty for the rural population, and abandonment of agriculture in many of these rural areas where the effects have been the most detrimental.

Activity One: Site Description and Characterization of Subzones

Kostanai Oblast is situated to the east of the Ural Mountains and extends 800 km. from north to south and to 400 km. from west to east. The northern part of Kostanai Oblast occupies the southwestern part of the West-Siberian Lowland, which transforms into Turgai plateau in the south. Most parts of the Kostanai Oblast are in arid zones where agriculture is risky due to unstable climatic conditions, droughts, short growing seasons, and sandy and stony soils.

Significant extension of the oblast from north to south causes change in the three

natural zones: forest steppe ("kolki steppes" are small insular groves of aspen and/or birch surrounded by steppe), steppe, and northern desert (semi-desert). The steppe zone is divided into several sub-zones: moderately droughty forbs-feather grass steppe on ordinary chernozem soils, droughty forbs-feather grass steppe on southern chernozem soils, moderately dry festuca–feather grass steppe on dark chestnut soils, dry xerophytic forbs-feather grass steppe on chestnut soils, sagebrush-feather grass desert steppe on light chestnut soils. The territory of the Kostanai Oblast is of particular interest as it presents all the main types of Kazakhstan's steppes and even small areas of northern desert and southern forest steppe. We assigned zonal types of steppes to the vegetation communities of watershed plains, which reflect climatic conditions of certain steppe sub-zones. Diversity within zonal types of steppes is caused by soil conditions (edaphic variants) and regional peculiarities of community composition (geographic variants).

This region has vast areas of fertile lands. Use of land for arable cropping in Kostanai Oblast started in the middle of the 19th century and significantly intensified during the period of immigration of Russian peasants (1909-1918). During this period, steppes with chernozem soils and forest steppe were ploughed up. Large scale ploughing of the steppes in Kazakhstan (1954-1960) was implemented according to the famous Soviet program for the development of virgin lands. Unfortunately in this period, many poor lands in the southern part of Kostanai Oblast were involved in development, namely dark chestnut sandy soils, chestnut carbonate soils, part of complexes of zonal soils, and solonetz soils.

At present, the northern part of the Kostanai Oblast has a higher proportion of agricultural development where the arable lands occupy 50–75% of the total land. As a result of cropland conversion, the extent of rangelands has been reduced, leading to degradation. In the latter parts of the 1990s, croplands have been abandoned due to economic decline and the associated costs of fuel and other necessary goods. According to Dyusenbekov (1998), areas of arable lands in 1990 occupied approximately 6,730 million hectares and had decreased by 15% in 1997. In 1999, according to Department of Agriculture of the Oblast Land Committee, the area of arable land in the Kostanai Oblast was 5,585 million hectares. Abandoned fields are now left to revegetate on their own and most of them have been transformed into weed fields.

Influence of land ploughing on vegetation. Cropland conversion of the steppe ecosystems in the region has resulted in a loss of the main steppe communities. Vegetation of each zone in the Kostanai Oblast has been transformed by ploughing as follows:

- Forest steppe zone: 50% of territory was ploughed up. Natural vegetation remained only at the edge of the forest steppe.
- Moderately droughty forbs-feather grass steppe on ordinary chernozem soils and droughty forbs-feather grass steppe on southern chernozem soil steppes were almost totally developed for agriculture.
- *Stipa rubens* and *Stipa Lessingiana* steppe had been totally destroyed by ploughing. These subzones have been converted to croplands.

Some areas remained inaccessible for agriculture on the steep slopes of the Tobol and Ayat river valleys, but they have been strongly transformed by overgrazing. Even complex steppes on solonetz soils had been ploughed up in these subzones (i.e., complex vegetation – heterogeneous vegetation cover comprised of plant communities which regularly alternate according to microrelief and

soil varieties). Only solonetz lands in the bottom of the Turgai depression and around the lakes remained untouched.

Subzone: moderately dry sheep's fescue-feather grass steppe on dark chestnut soils. The climatic conditions for this subzone are as follows: the mean annual precipitation is 265 mm., ranging from 100-400 mm. over a 60-year period. Storage of water in the snow cover is 60-70 mm. The frost-free period is 115-130 days. The sum of temperatures over 10°C is 2,470 to 2,600°C. The mean July temperature is 21°C, while the mean January temperature is -18°C, with an absolute maximum of +39°C and minimum of –44°C. The hydrothermal coefficient is 0.7.

In this subzone, the sheep's fescue–feather grass steppe had been destroyed by grain farming. Some areas of this steppe remained on the slopes of Torgai plateau and the river valleys. *Stipa capillata* steppes on sandy loam soils have been partly ploughed up. *Stipa pennata* steppes on sandy soils remained untouched. In this subzone, complex steppes were ploughed up to a lesser extent than the same steppes in the north, but some areas were still ploughed up by as much as 20%.

Subzone: dry xerophytic forbs-feather grass steppe on chestnut soils. The climatic conditions for this subzone are as follows: the mean annual precipitation is 220 mm. The sum of temperatures over 10°C is 2,500 to 2,650°C. The mean July temperature is 22°C, while the mean January temperature is -14°C. The hydrothermal coefficient is from 0.6.

In this subzone, massive agricultural development was mainly on the plains with xerophytic forbs-feather grass steppe on chestnut carbonate soils. The slopes of the plateau, river valleys, and ravines remain untouched. Complex steppes were ploughed up by 15-30%.

Subzone: sagebrush-feather grass desert steppe on light chestnut soils. The climatic conditions for this subzone are as follows: the mean annual precipitation is 190 mm. The sum of temperatures over 10°C is 2,900 to 3,100°C. The mean July temperature is 23°C, while the mean January temperature is -17°C. The hydrothermal coefficient is from 0.4-0.5.

In this zone, all types of steppe have remained. It should be noted that sagebrush-feather grass (*Stipa sareptana*) steppes on light chestnut soils occupy huge areas here, and this is the only place in Eurasia in which they exist. At present these steppes are subject to local overgrazing and fires.

Subzone: semidesert zone on brown soils. The climatic conditions for this subzone are as follows: the mean annual precipitation is 160 mm. The sum of temperatures over 10°C is 3,000 to 3,200°C. The mean July temperature is 24°C, while the mean January temperature is -13°C. The hydrothermal coefficient is from 0.3.

In the extreme south of the study area in the semidesert, natural vegetation has remained, though affected by heavy livestock grazing in the past. Vegetation is mostly represented by feather grass (*Stipa sareptana*)-sagebrush communities on brown soils and saltwort (*Atriplex cana, Anabasis salsa*)-black sagebrush (*Artemisia pauciflora*) communities and their complexes on saline soils.

Activity Two: Characterization of Vegetation Dynamics

Increased trends in plant productivity are indicated from our remote sensing analysis of northern Kazakhstan. The net primary productivity (NPP) trends from the normalized difference vegetation index (NDVI) time series suggest a 30 to 50 kg. C/ha. increase from 1982 to 1999. Climate and vegetation dynamics for the region indicate high correspondence of the vegetation with the

Table 1 - Population, land, crops, and livestock in the study area.

In Thousands	Naurzum	Amangeldy	Jangeldy
Human Population, 2001	16.1	21.1	19.2
Cropped Area, 2003 ha.	172	21	8.1
Pasture, Ha.	268	2,378	-
Mean Crop Area/Person, Ha.	10.7	1	0.4
Hayland, Ha.	2.2	99.8	-
Cattle, 2003	14.6	20.3	18.7
Sheep and Goats, 2003	10.3	27.0	26.7
Horses, 2003	2.5	6.7	5.4
Mean # Sheep Units/Person	6	8	8

Source: Kostanai in Figures, 2002

rainfall pattern, both seasonally and between years. The remote sensing data for the region confirms this relationship for the years 1981 to 2001. These trends seem to be more prevalent in the southern region of the Kostanai Oblast, where a greater area of land abandonment took place.

The study area was defined as three districts (rayons) in the southern part of Kostanai region (oblast), which form a north-south ecological transect from the semi-steppe district of Naurzum to the semi-desert southern districts of Amangeldy and Jangeldy. These districts are mainly pastoral due to the low precipitation, with the exception of Naurzum, where wheat remains an important crop even though cultivation is risky. Most of this area had formerly been included in Torgai Oblast, which was merged with Kostanai Oblast in the 1950s.

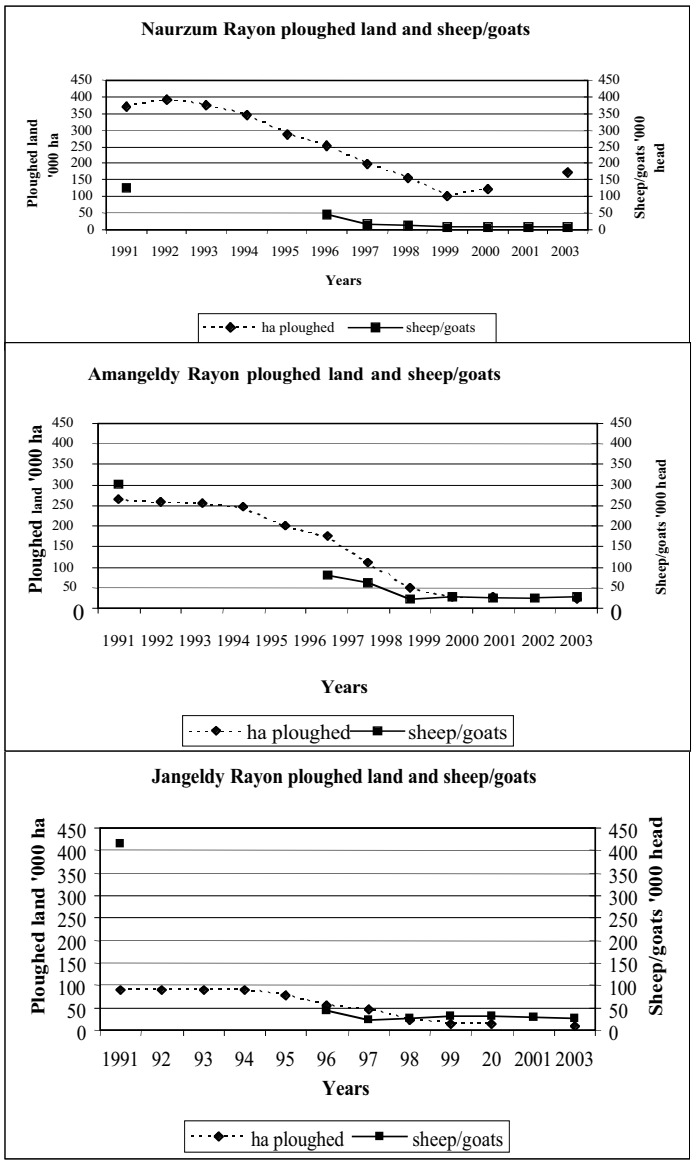
General data on land use, population, cropping, and livestock was obtained for each district, for the past and present (Table 1). This included published statistics and cartography as well as unpublished data on state farm (sovkhoz) production records. Within the districts, two former state farms were selected in consultation with district officials. More detailed data on geobotany, livestock, and land use was collected on each of these six farms. Visits were made to their village centers to interview former professional farm employees, village leaders, and livestock owners.

Traveling the transect involved visual familiarization with landscapes and ecozones, checking main vegetation types against the one:one million scale vegetation map of Kostanai Oblast, and taking GPS points of currently-grazed pastures along the study route. Interviews were carried out with shepherds regarding types and locations of pastures grazed in each season, and shepherds' observations on their past and current condition.

Interviews were carried out with officials at three levels: oblast, rayon, and village. The team outlined the objectives of the GL-CRSP project. Private livestock owners and former sovkhoz shepherds were also interviewed within each former sovkhoz. In some cases these individuals were selected by village officials and in other cases, met along the route. Questions included:

- Previous and current livestock grazing patterns in each season.
- Numbers of cattle, sheep, goats, and horses kept in the sovkhoz, including breeds of sheep kept.
- Marketing of animals and their products, and prices currently obtained.
- Land areas used for cropping and hay cutting, and registration of private land parcels since the breakup of the sovkhoz.

Figure 1 - Change in area of ploughed lands and sheep/goal populations, 1991-2003.



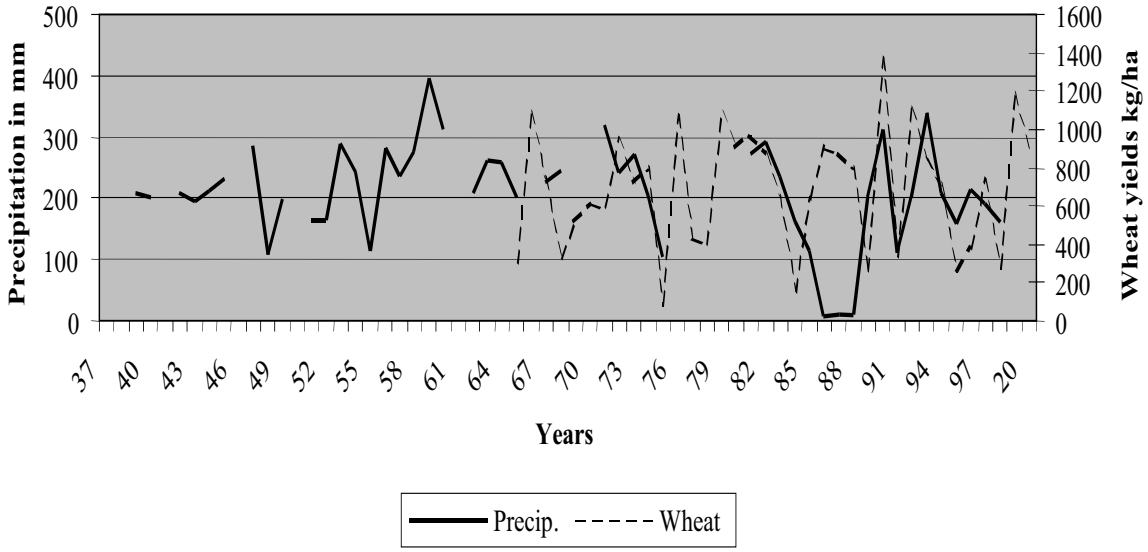
- Availability of credit or other development programs for livestock owners.
- Proposed means and investments to re-develop the livestock sector.

Since Kazakhstan's independence in 1991, the most significant event in the rural economy of the study area has been the great loss of livestock following implementation of national policies on state farm privatization and economic reform in the early and mid 1990s. In the Kostanai study regions, between 91-93% of the smallstock held in 1991 has gone, as well as 67-78% of cattle and 50-64% of horses (Figur 1). Animals, particularly sheep, were bartered for foodstuffs at very disadvantageous exchange rates, and used to pay off state farm debts. By 2003, one can detect a positive trend in the recovery of livestock within the two more southern and pastoral districts of the study area. In Jangeldy district, the population of sheep and goats rose by 25% between 2000-2003.

The area of ploughed land, cropped mainly to wheat, has also declined since the early 1990s, as state farm inputs were cut off following economic restructuring. Overall, in the three study areas, the area of ploughed land has been reduced to a third of the former levels (Figure 1). The three study areas have a low precipitation of 175 –300 mm. per year, with a gradient decreasing from north to south. However, there is a high degree of variability in annual precipitation, which has resulted in highly variable annual wheat yields. The mean wheat yield in the study area over 35 years from 1965 to 2000 was 680 kg./ha., ranging from a low of less than 120 kg./ha. in 1984 to a high of 1,600 kg./ha. in 1990. The quality of wheat grown in the study area is considered very good, due to a high percentage of gluten in the wheat. In the era of the USSR, wheat from this area was transported directly to Moscow for the elites.

The district of Naurzum straddles the former limit of cultivation marked by the Russian administration in 1913. Much of the higher ground of this district was converted from pasture to wheat land during the Virgin

Figure 2 - Long-term precipitation and wheat yields in Naurzum Rayon, 1937-2000.



Source: Unpublished precipitation records, Naurzum Meteorological Station (courtesy of Tatiana Bragina) and Rayon statistics from Naurzum Akimat.

Land campaign of the 1950s. This district now retains more of its wheat land than the two more southern and drier districts of Amangeldy and Jangeldy, as shown in Figure 1, which also shows that the area of ploughed land is increasing in Naurzum since its lowest point in 1999. Table 1 shows that there is a far higher ratio of cropped land per person in this district compared to the two southern districts. Further analysis of wheat yields over time in each district will be provided in the project's final report.

Activity Three: Land Use Survey and Analysis

Farmers interviewed during the fieldwork indicated that wheat growing was profitable in Naurzum district, due to current good prices they received of around USD $65 per metric ton. However, further south in the drier districts of Amangeldy and Jangeldy, private farmers found wheat growing much too risky and were focusing more on increasing their livestock. Wholesale prices of wheat are very difficult to obtain, as these are subject to negotiation with buyers and exporters and are considered a business secret. Most villagers were not aware of the government's new village and rural development ("Aul") program, or if aware, did not believe they would benefit from credit, which requires immovable collateral such as a flat in a city or a commercial property. Villagers point out that neither land nor livestock are accepted as collateral.

Agricultural credit has not been available for ordinary farmers. One former director of a livestock state farm in the dry and remote southern area made the following remarks about credit: "To help villagers it is better to provide livestock, not cash. Cash just comes and goes. In Soviet times everything was provided and people wasted their livestock, not trying to save them. Now people see how silly they were and would be ready to move their animals away to winter pastures and really try to take care of their animals as they appreciate livestock now. Now we think the state should support us; we don't ask the state to give us

something for free but to lend us something. We are not businessmen so we don't need money as we do not have investments to make, but we want livestock to be loaned over three years, and then return some to the state after that period."

Some local officials and farmers believe that agricultural credit should be made available only to successful private companies that have managed to establish commercial farming in the region. They argue that such companies have proved their ability to make a profit, whereas many villagers have lost the will to work hard following the collapse of state productive organizations.

In the more remote villages furthest from large urban centers, people have to sell their animals to traders at lower prices due to the cost of transport. However, farmers are beginning to group together to share the costs of hiring transport in order to market their animals in towns and cities many hundreds of kilometers distant.

Changes in livestock grazing systems from the pre-Soviet period to the present day. The three districts comprising the study area were formerly the summer grazing grounds for thousands of nomadic Kazakhs from other regions of the country, prior to the October Revolution and formation of collective farms in the 1920s. The area was intensively researched in the early 1950s in preparation for the Virgin Land campaign, the goal of which was large-scale conversion of steppe land to state wheat farms. We were able to locate rare typewritten scientific reports from this period in district offices. The project is grateful to Tatiana Bragina for making data and manuscripts from the 1930s available to us.

Before the revolution, the study area was incorporated into the Russian administrative unit of Torgai uezd (district), as part of Kostanai Oblast (Ministry of Agriculture, 1954). According to several elderly informants, collective farms, termed kolkhoi, were organized in the study areas beginning in 1924, under the policy of Lenin. Prior to this, clan groups of nomads and semi-nomads had wintering grounds (kystau) based around the reed beds of rivers (kopar) to provide shelter from the cold winter. Each clan group was in a unit (aul) of between 50-60 households, under a wealthy clan leader, called a bai. Bais could own up to 13,000 head of livestock, but as one informant explained, "rich people does not mean one person," meanng that different auls would be richer or poorer in livestock, with one person in charge.

The groups would move to summer pastures around the lakes that had been flooded in spring and therefore provided good forage. In the spring, summer, and autumn they would live in yurts (kigiz uyi) moved by camels with carts. In autumn, the richer bais would have many workers prepare hay for the winter, when the aul groups would return to their winter quarters along the rivers and stay in houses made of mud bricks with turf roofs. The extent of movement depended on the livestock wealth of the aul group. The richest leaders and their auls would move up to 200 km. in one season.

In the late 1920s, these clan groups were organized into permanent settlements in the wintering areas, with support from the state. In 1928, under Stalin, livestock began to be confiscated and placed into kalkhozi. These continued, with many organizational changes, until the mid 1960s in the study areas, when the kalkhozi were combined into sovkhozi, whose members became directly employed by the state. In the kalkhozi, animals were taken on longer seasonal migrations than under the sovkhoz, with 20 to 30 families grouping together to "chase good pastures" so that their livestock would put on fat easily during summer and autumn.

Sovkhoz workers were permitted to keep private animals, which were usually the Edilbai Kazakh meat breed of sheep, cattle for household milk provision, and Kazakh goats whose down was used to make warm clothing for the family. These private animals were either grazed around the villages under communal rotational arrangements (kyzk), or if a family was related to a sovkhoz shepherd, their private animals could accompany the sovkhoz flocks to distant pastures.

Livestock grazing systems. Rural populations declined in these southern districts after the end of the Soviet Union, as younger people migrated to cities in search of employment when the state farms dissolved. However, the population levels are now stabilizing, as those that remain in villages are either pensioners receiving state assistance, or farmers committed to making a livelihood from livestock and cropping.

Rural people are relocating, moving out from some small and remote settlements that no longer receive government services, to villages with better access to grazing, water, or services. One senior district administrator noted that house prices are rising in the district center as villagers move in; he commented, "Now people know they should stay in one place, as there is no help so they have to work for themselves and not move elsewhere."

Around some villages, within a radius of one to three kilometers, experienced shepherds note that pastures have become more degraded since the early 1990s, as animals are no longer moved away to seasonal pastures. At present, some villages have an almost denuded belt of sand around them. However, other shepherds state that the peri-village denudation was worse in the state farm Soviet era, as many thousands of animals would be brought back regularly around the villages for shearing.

Distant pastures that were seasonally grazed in the Soviet period now appear to be in very good condition, due to the great drop in stocking levels. Very few livestock now graze away from the village perimeters. Shepherds in the southern and driest part of the transect recognize that moving animals to graze on winter sand dune pastures provides them with better nutrition and at less cost than stall-feeding over winter. The former state farms practiced this system, which was based on traditional seasonal movements by Kazakh nomads prior to the formation of the Soviet Union.

Only a few villagers are returning to the traditional methods of moving animals away to graze at different seasonal pastures. Small groups of neighbors are getting together to hire shepherds within their villages to take cattle away to seasonal grazing areas, but this is not being done for sheep and goats due to the cost of hiring shepherds.

Potential for increasing economic returns of livestock to households through investment in marketing facilities and livestock technical inputs. Villagers need credit to build up their flocks after the decimation of state farm stock following the economic crisis of the early to mid-1990s. Restocking schemes have operated successfully in other parts of the world, following devastating losses of livestock among pastoralists (Oxby 1994). Most recently, schemes for restocking pastoralists and providing group credit for livestock infrastructure have been implemented in Mongolia with the assistance of FAO (Hoffman et. al. 2003). There are several models that could be tried, which would require the support of district and provincial administrations. Restocking schemes could assist low-resource farmers to build up their flocks of the local meat-type sheep breed. Although fine wool Merino sheep were

formerly kept on some state farms, it is unlikely that these will be profitable in the near future for private farmers in the study area.

Enabling all villagers to once again move to seasonal pastures will require credit with which they can purchase mechanical equipment. Research among pastoralists in southeast Kazakhstan has indicated that the key items of equipment required for seasonal movement are trucks, tractors, and water pumps (Kerven et. al. 2003). Some villagers say they are prepared to form groups to share capital resources and repay credit on a group basis. Such schemes have worked well elsewhere in Central Asia. For example, the Aga Khan Foundation has helped establish village organizations in rural Tajikistan that receive agricultural equipment on credit for one to five years. The village organizations are supported through the Mountain Societies Development Support program, funded in part by USAID.

Activity Four: Land Tenure and Cropping for Four Areas in Kostanai Oblast

Naurzum district: Sosnovka sovkhoz (Ulendi village area). The sovkhoz land included 25,000 hectares of ploughed area in 1990, of which 19,000 hectares was planted to wheat. Average wheat yields from 1981-1990 were 990 kg./ha., ranging from a low of 120 kg./ha. in 1984 to 1,630 kg./ha. in 1990. The ploughed land has now been divided into private leased parcels. Upon the dissolution of the sovkhoz in 1997, sovkhoz workers received land shares of 22.6 ha. per person; some people sold their shares of cropland to people in the district center town of Dokuchaevka. Two limited companies now own 7,000 ha. of ploughed land and 35,700 ha. of pasture, which is nearly half the total area of pasture. A further 53 private registered "peasant" farms have 13,300 ha. of ploughed land and 42,000 ha. of pastures. As noted, not all these private farms belong to Ulendi villagers. Land has to be privately registered in order to be cultivated. There is also an area of 11,200 ha. of pasture land around the villages which is allocated communally for grazing.

Two private registered farmers were interviewed. One has an area of 725 ha. of pasture 19 kilometers from the village center, and another 158 ha. of cropland in another location within the former sovkhoz lands. He does not use his grazing land at all, as he does not have enough livestock to justify the cost of moving animals there; instead he lets his animals graze around the village area where he lives. On his cropland, he has an artesian well and grows melons.

The other farmer lives in an abandoned village that was one of the three sovkhoz departments. This village used to have 60 families but now has only 3; the farmer, his two married sons, and a married daughter who work their land and livestock together. The village department became a limited company in 1998 after the sovkhoz dissolved, but that was a drought year and the company became bankrupt. The family has 180 ha. of ploughed land and has been growing wheat for six years on the land without rotation, fallowing 40 ha. each year. In 2002, a wheat disease appeared and he applied chemical treatment for the first time. No fertilizers have been used. They planted 160 ha. of wheat in 2002. They were paid USD $62 per ton. The main farming costs were spare parts for the old Soviet-era tractors and a combine (USD $660), diesel (bartered for wheat at a cost of USD $230), and treatment of wheat seed (USD $200). Seed is usually saved from the previous harvest. The total harvest in 2002 was not given, but mean wheat yields for Sousnovki sovkhoz were 990 kg./ha. from 1980-1990. This would give a harvest of 158 tons on 160 ha. After

subtraction of major costs, the return would be about USD $8,700 divided between four families, or USD $2,200 per family per year.

The head of this farming family expected that in future, livestock farming would be more profitable than wheat farming. He explained that their cropland was small and the area is risky, with droughts in one of every four years. Between them, the families have 30 cattle, 100 sheep and goats, and ten horses. Five tons of the grain crop was used as winter feed and 60 tons of hay was also collected.

Koktal sovkhoz (Dokuchaevka village area, now called Karamendy). Koktal sovkhoz had 29,000 ha. of ploughed land in 1990, of which 18,000 has planted to wheat. Average wheat yield between 1981-1990 was 620 kg./ha., ranging from a low of 20 kg./ha. in 1984 to a high of 960 kg./ha. in 1986. The present area of ploughed land is 4,800 ha.

Amangeldy District (Imanovski sovkhoz, now Urpek village area). The sovkhoz formerly had 3,000 ha. ploughed to wheat, and fodder crops (1,500 ha. of *Agropyron* and 500 ha. of Sudan grass). The average wheat yield was about 450 kg./ha. and the maximum in one out of four years was 1,200 kg./ha.

There are 30 registered private peasant farms on the haylands near the Karatorgai River to the east of the village center. These farms are used for hay cutting and the livestock grazes elsewhere. Some farms are now also used for growing potatoes. One informant, a former shepherd who is a registered peasant farmer, planted 10 ha. of grain on his land in 2002, using irrigation. The crop grew well, but he could not obtain any harvesting equipment so the plot was not harvested.

Sovkhoz (now Baighabul village area). The sovkhoz has hayland, mostly south of the river. Most of the hayland area has been divided into private plots among 30 registered peasant farmers, of whom 15 are residents of the district center 15 km. distant. There is one limited company that was organized between 30 villagers to cut and sell hay. Only two members of this company remain, a former sovkhoz director and his accountant. Their holdings of hayland amount to some 2,000 ha. and is the major part of the former sovkhoz hayland.

Conservation of biodiversity. The large-scale changes in land use and livestock populations in the past decade have had obvious impacts on the flora and fauna of the study area. Some impacts are noted by the senior Forestry Department official responsible for wildlife management in Amangeldy district. He observes that the number of wolves has declined recently. This is due to the great decrease in livestock that was a winter food source for wolves, and to the farmers' new practice of burning reeds around water points to create better haylands, which has removed hiding areas for wolves. As livestock have become scarce, people are illegally hunting more wild boars to provide meat. Several people mentioned an observed increase in the number of small mammals (e.g., gophers and marmots) due to the decrease in livestock that formerly disturbed their burrows.

Uncontrolled burning of grass and reeds and cutting trees for firewood has also had negative impacts on the bird populations, whose nesting areas are disturbed. In the Soviet period, accidental fires were put out by worker brigades from the villages. The question of fires was raised by a number of people. Some noted that with the great reduction in livestock, there was increased fire risk from dried grass stands which were left ungrazed each year. Others commented that fires were deliberately set by hunters to flush out wildlife, by livestock owners to promote early green growth, and by farmers to remove crop residues. One senior district official remarked

that the large scale of these steppe fires was adding CO_2 to the atmosphere.

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Gender

Key research activities were led by women scientists from Kazakhstan and England. These women were integral team members of the project. These included:

- Dr. Carol Kerven, Ph.D. (Co-PI, and co-leader of the project), Independent Consultant. Dr. Kerven served as the co-leader of the project and developed the social history of changes in the Kostanai region and the social economic evaluation for the project.
- Dr. Ekaterina Rachkovskaya (Co-PI of the project), Laboratory of Geobotany of the Institute of Botany and Phytointroduction, Kazakhstan Ministry of Education and Science. Professor Ekaterina Rachkovskaya was the main advisor on the selection of field sites and supplied invaluable information and maps on the vegetation and land use of the Kostanai Oblast.
- Dr. Oxana Marynich (Ph.D.), Senior Researcher, Laboratory of Geobotany of the Institute of Botany and Phytointroduction, Kazakhstan Ministry of Education and Science. Dr. Oxana Marynich provided excellent field survey information for the geobotanical status of vegetation during the summer field survey and also provided analysis of the vegetation data.
- Dr. Tatyana Bragina (Administrator for Water and Forestry Resource Department, Kostanai Oblast). Professor Tatyana Bragina developed contacts with administrators in the various rayons during the field study in 2003. She also provided important information on the ongoing conservation efforts in the region.

Policy

Senior government agricultural officials, both at the provincial and district levels, have few plans or concepts of how to increase the stock of sheep in the study areas. One district official responsible for livestock commented that he had "nothing but a pen to help livestock farmers." New national and provincial agricultural programs are aimed at improving veterinary services, creating pedigree horse stud farms, and rehabilitating meat and skin processing factories in the urban areas.

Local government officials at the district and village levels were very interested in discussing how the rural economy could be revitalized, and had many worthwhile suggestions. The perception of the local population is that their region is relatively neglected due to its remoteness from the more populated grain growing areas of northern Kostanai.

Agricultural officials do not consider that the fine wool sheep industry can or should be revived in the province, as it cannot compete with Australian wool due to the cost of winter fodder for sheep in Kostanai. Their assessment is undoubtedly correct.

Farmers are now concentrating on raising the heavier local meat sheep breeds, as these bring higher prices than the smaller Merino types. These heavier sheep are also easier to raise without access to high quality winter feed.

Some local officials and farmers believe that agricultural credit should be made available only to successful private companies that have managed to establish commercial farming in the region. They argue that such companies have proved their ability to make a profit, whereas many villagers have lost the will to work hard following the collapse of state productive organization.

Outreach

The project trained a Kazakh scientist in ecosystem modeling and integration of spatial analysis. Policy discussions were held with local decision makers at the oblast, rayon, and household levels regarding land use management options.

Developmental Impact

The results of the project will provide land use management options for various croplands and rangeland regions of Kazakhstan and surrounding countries. The land use management options are designed to lead to a sustainable soil carbon level and economic sustainability for the different ecosystems being studied.

Other Contributions

The project assessed the study area's land use management strategy to improve long-term economic markets for conservation and sustainable land use for the region relative to cropping and livestock systems, as well as conservation of soils, water, and vegetation. We also assessed the alternative coping strategies of land use management to maintain land productivity and livelihood, and the conservation trade-offs considered in the Kostanai Oblast where wetlands are an important natural resource.

Collaborating Personnel

Yevgeny Bragin, Senior Researcher of the Naurzum State Reserve.

Tatyana Bragina, Officer of the Kostanai Oblast Administration of Water and Forestry.

Carol Kerven, Independent Consultant.

Oxana Marynich, Senior Researcher, Laboratory of Geobotany of the Institute of Botany and Phytointroduction.

Ravil Sadvokassov, Junior Scientific Researcher, Laboratory of Geobotany of the Institute of Botany and Phytointroduction.

Collaborating Institutions

Colorado State University
Natural Resource Ecology Laboratory
Fort Collins, CO 80523

Laboratory of Geobotany of the Institute of Botany and Phytointroduction
Kazakhstan Ministry of Education and Science
Phone: 732-72-915097
Fax: 732-72-917938
Email: envirc@nursat.kz

Principal Investigators

Lead Principal Investigator. Dennis Ojima, Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, CO 80523. Phone: 970-491-1976; Fax: 970-1965; Email: dennis@nrel.colostate.edu.

Co-Principal Investigators. Sayat Temirbekov, Laboratory of Geobotany of the Institute of Botany and Phytointroduction, Kazakhstan Ministry of Education and Science; Ekaterina Rachkovskaya, Laboratory of Geobotany of the Institute of Botany and Phytointroduction, Kazakhstan Ministry of Education and Science; and Carol Kerven, Independent Consultant.

Project Expenditures

Global Livestock CRSP
USAID Grant No. PCE-G-00-98-00036-00
Approved Program Budgets

Institutions	Principal Investigator	Year 20 98/99	Year 21 99/00	Year 22 00/01	Year 23 01/02	Year 24 02/03	Total
Univ. of Calif., Davis	Laca	$300,000.00	$300,000.00	$468,000.00	$368,000.00	$445,879.00	$1,881,879.00
Univ. of Calif., Davis	Allen	$0.00	$0.00	$0.00	$0.00	$79,780.00	$79,780.00
Univ. of Calif., LA	Neumann	$300,000.00	$300,000.00	$155,954.00	$0.00	$130,000.00	$885,954.00
Colorado State	Swift	$350,000.00	$300,000.00	$137,500.00	$350,000.00	$349,999.00	$1,487,499.00
Colorado State	Ojima	$0.00	$0.00	$0.00	$49,970.00	$0.00	$49,970.00
Colorado State	Galvin	$0.00	$0.00	$0.00	$54,399.00	$0.00	$54,399.00
Texas A&M Univ.	Stuth	$275,000.00	$300,000.00	$370,000.00	$375,000.00	$439,340.00	$1,759,340.00
Utah State Univ.	Coppock	$308,000.00	$400,000.00	$590,000.00	$550,000.00	$600,000.00	$2,448,000.00
Univ. of Wisc.	Shapiro	$300,000.00	$200,000.00	$25,000.00	$25,000.00	$0.00	$550,000.00
Univ. of Wisc.	Moremond	$100,000.00	$150,000.00	$350,000.00	$350,000.00	$439,949.00	$1,389,949.00
Univ. of Wisc.	Childress	$0.00	$0.00	$0.00	$54,343.00	$0.00	$54,343.00
Univ. of Wisc.	Thomas/Brent	$0.00	$0.00	$0.00	$54,000.00	$0.00	$54,000.00
Univ. of Wyoming	Miller	$0.00	$0.00	$0.00	$0.00	$173,280.00	$173,280.00
Syracuse Univ.	McPeak	$0.00	$0.00	$0.00	$0.00	$102,074.00	$102,074.00
Montana State U.	Graumlich	$0.00	$0.00	$0.00	$0.00	$91,861.00	$91,861.00
	Total	$1,933,000.00	$1,950,000.00	$2,096,454.00	$2,230,712.00	$2,852,162.00	$11,062,328.00

Global Livestock CRSP
USAID Grant No. PCE-G-00-98-00036-00
Expenditures by Program

Institutions	Principal Investigator	Year 20 98/99	Year 21 99/00	Year 22 00/01	Year 23 01/02	Year 24 02/03	Total
Univ. of Calif., Davis	Laca	$ 256,234.59	$ 286,008.00	$ 468,000.00	$ 454,029.14	$ 430,120.24	$ 1,894,391.97
Univ. of Calif., Davis	Allen	$ -	$ -	$ -	$ -	$ 49,027.04	$ 49,027.04
Univ. of Calif., LA	Neumann	$ 300,000.00	$ 329,170.00	$ 152,185.54	$ -	$ 130,000.00	$ 911,355.54
Colorado State	Swift	$ 348,833.38	$ 300,000.00	$ 136,199.98	$ 255,921.71	$ 387,236.96	$ 1,428,192.03
Colorado State	Ojima	$ -	$ -	$ -	$ 3,514.62	$ 50,879.24	$ 54,393.86
Colorado State	Galvin	$ -	$ -	$ -	$ 40,589.65	$ 9,380.35	$ 49,970.00
Texas A&M Univ.	Stuth	$ 275,000.00	$ 348,400.00	$ 370,000.00	$ 376,904.17	$ 499,337.34	$ 1,869,641.51
Utah State Univ.	Coppock	$ 308,000.01	$ 428,417.89	$ 561,876.20	$ 541,779.35	$ 600,000.00	$ 2,440,073.45
Univ. of Wisc.	Shapiro	$ 299,504.70	$ 200,000.00	$ 25,000.00	$ 25,000.00	$ -	$ 549,504.70
Univ. of Wisc.	Moermond	$ 100,000.00	$ 156,250.00	$ 350,000.00	$ 309,913.14	$ 378,522.07	$ 1,294,685.21
Univ. of Wisc.	Childress	$ -	$ -	$ -	$ 1,683.15	$ 52,659.85	$ 54,343.00
Univ. of Wisc.	Thomas/Brent	$ -	$ -	$ -	$ 2,344.64	$ 44,162.63	$ 46,507.27
Univ. of Wyoming	Miller	$ -	$ -	$ -	$ -	$ 206,870.00	$ 206,870.00
Syracuse Univ.	McPeak	$ -	$ -	$ -	$ -	$ 59,283.82	$ 59,283.82
Montana State U.	Graumlich	$ -	$ -	$ -	$ -	$ 35,937.70	$ 35,937.70
	TOTAL	$ 1,887,572.68	$ 2,048,245.89	$ 2,063,261.72	$ 2,011,679.57	$ 2,933,417.24	$ 10,944,177.10

Global Livestock CRSP
USAID Grant No. PCE-G-00-98-00036-00
Summary of Host Country Contributions and Other External Support

Host Country	Year 20 98/99	Year 21 99/00	Year 22 00/01	Year 23 01/02	Year 24 02/03	Total
Bolivia	$50,632.00	$49,000.00	$108,100.00	$105,000.00	$98,840.00	$411,572.00
Ecuador	$27,240.00	$34,400.00	$105,700.00	$62,500.00	$139,311.00	$369,151.00
Ethiopia	$44,716.67	$21,500.00	$3,500.00	$42,479.87	$6,000.00	$118,196.54
Kazakhstan	$71,674.00	$54,713.00	$16,812.50	$56,625.00	$23,113.00	$222,937.50
Kyrgystan	$490.00	$500.00	$500.00	$23,000.00	$6,000.00	$30,490.00
Kenya	$85,933.33	$2,293,833.00	$7,945.00	$7,000.00	$27,783.00	$2,422,494.33
Mexico	$29,502.00	$49,600.00	$115,754.00	$21,000.00	$42,220.00	$258,076.00
Tanzania	$32,758.33	$51,800.00	$2,141.00	$0.00	$19,207.00	$105,906.33
Turkmenistan	$3,500.00	$5,000.00	$4,625.00	$0.00	$5,000.00	$18,125.00
Uganda	$23,158.67	$68,000.00	$0.00	$0.00	$17,159.00	$108,317.67
Uzbekistan	$18,500.00	$28,000.00	$15,000.00	$10,700.00	$14,700.00	$86,900.00
Total HC Contrib.	$388,105.00	$2,656,346.00	$380,077.50	$328,304.87	$399,333.00	$4,152,166.37
Leveraged Funds*	$887,404.00	$2,214,717.00	$573,972.78	$935,000.00	$1,829,333.00	$6,440,426.78
TOTAL External Support	$1,275,509.00	$4,871,063.00	$954,050.28	$1,263,304.87	$2,228,666.00	$10,592,593.15

***Support from sources other than GL-CRSP, e.g., NGOs, other funding agencies, etc. that further GL-CRSP research**

Global Livestock CRSP
USAID Grant No. PCE-G-00-98-00036-00
Matching Contributions from U.S. Institutions

Institutions	Principal Investigator	Year 20 98/99	Year 21 99/00	Year 22 00/01	Year 23 01/02	Year 24 02/03	Total
Univ. of Calif., Davis	Laca	$ 83,836.00	$ 86,210.00	$ 147,795.00	$ 158,552.00	$ 113,727.00	$ 590,120.00
Univ. of Calif., Davis	Allen	$ -	$ -	$ -	$ -	$ 12,200.00	$ 12,200.00
Univ. of Calif., LA	Neuman	$ 75,297.00	$ 86,124.00	$ -	$ -	$ 33,800.00	$ 195,221.00
Colorado State	Swift	$ 87,504.13	$ 77,827.53	$ 50,344.04	$ 53,237.52	$ 44,509.94	$ 313,423.16
Colorado State	Ojima	$ -	$ -	$ -	$ -	$ 12,600.00	$ 12,600.00
Colorado State	Galvin	$ -	$ -	$ -	$ -	$ 9,899.82	$ 9,899.82
Texas A&M Univ.	Stuth	$ 69,704.00	$ 106,737.52	$ 162,774.26	$ 118,258.17	$ 254,589.45	$ 712,063.40
Utah State Univ.	Coppock	$ 70,213.17	$ 116,896.92	$ 221,948.85	$ 134,194.00	$ 133,148.69	$ 676,401.63
Univ. of Wisc.	Shapiro	$ 125,871.02	$ 133,657.34	$ 47,200.58	$ 7,309.00	$ -	$ 314,037.94
Univ. of Wisc.	Moermond	$ 74,279.34	$ 33,541.45	$ 34,388.00	$ 45,471.47	$ 52,947.33	$ 240,627.59
Univ. of Wisc.	Childress	$ -	$ -	$ -	$ -	$ 15,764.89	$ 15,764.89
Univ. of Wisc.	Thomas/Brent	$ -	$ -	$ -	$ -	$ 15,602.83	$ 15,602.83
Univ. of Wyoming	Miller	$ -	$ -	$ -	$ -	$ 41,676.00	$ 41,676.00
Syracuse Univ.	McPeak	$ -	$ -	$ -	$ -	$ 22,941.03	$ 22,941.03
Montana State U.	Graumlich	$ -	$ -	$ -	$ -	$ 17,238.71	$ 17,238.71
	TOTAL	$ 586,704.66	$ 640,994.76	$ 664,450.73	$ 517,022.16	$ 780,645.69	$ 3,189,818.00
	Percentage	31.08%	31.29%	32.20%	25.70%	26.61%	29.15%

Glossary

A-AARNET	ASARECA Animal Agriculture Research Network
ACT	Almanac Characterization Tool
ADB	Asian Development Bank
ADDS	African Data Dissemination Service
AFD	Action for Development
AGIDS	Amsterdam Institute for Global Issues and Development Studies
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
ALIN	Arid Lands Information Network
ALRMP	Arid Lands Resource Management Project
ANPP	Annual Net Primary Productivity
APEIS	Asia-Pacific Environmental Innovation Strategy Project
APHIS	Animal and Plant Health Inpection Service
ARC	Agriculture Research Council
ARD	Association for Rural Development
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
ASF	Animal Source Foods
AVHRR	Advanced Very High Resolution Radiometer
BASIS CRSP	Broadening Access and Strengthening Market Input Systems Collaborative Research Support Program
BIFAD	Board for International Food and Agriculture Development
BLPDP	Borana Lowlands Pastoral Development Project
BOD	Biochemical Oxygen Demand

BREB	Bowen Ratio EnergyBalance
CAP	Community Action Plan
CARE	Cooperative for American Remittance to Europe, Inc.
CAREC	Central Asian Regional Environmental Center
CCMS	Committee on the Challenges of the Modern Society
CDC	Centro de Datos para la Conservacion
CER-DET	Centro de Estudios Regionales para el Desarrollo de Tarija
CERES	Centro de Estudios de la Realidad Económica y Social
CGIAR	Consultative Group on International Agricultural Research
CHARM	Collaborative Historical African Rainfall Model
CIAT	Centro Internacional de Agricultura Tropical
CIAD	Center for International Agriculture and Development
CIEC	Centro Interdisciplinario de Estudios Comunitarios (Interdisciplinary Center for Community Studies)
CIFA	Community Initiatives Facilitation and Assistance
CMO	Crisis Mitigation Office
COD	Chemical Oxygen Demand
CP	Crude protein
CRSP	Collaborative Research Support Program
CSU	Colorado State University
CUCSUR	Centro Universitario de la Costa Sur, Universidad de Guadalajara
DANIDA	Danish International Development Agency
DARCA	Desertification and Regeneration for Central Asian Rangelands
DMC	Drought Monitoring Center
DO	Dissolved Oxygen
DOM	Digestible Organic Matter
DPPC	Drought Preparedness and Prevention Commission

EARO	Ethiopian Agricultural Research Organization
EDC	Education Development Center
EEP	External Evaluation Panel
ELEA	Ethiopian Livestock Exporters Association
ELFORA	Agro-Industrial subsidiary of MIDROC Corp.
ELS	Extensive Livestock Production Systems
EPIC	Environmental Policy Integrated Climate Model
EQIP	Environmental Quality Improvement Program
ESA	Ecologically Sound Agriculture
EU	Edgerton University
EW & FISU	Early Warning and Food Information System Unit
EWD	Early Warning Department
EWS	Early Warning System
FAO	Food and Agriculture Organization, United Nations
FAO FSAU	FAO Food Security Assessment Unit
FESNARE	Faculty of Environmental Studies and Natural Resources
FEWS NET	Famine Early Warning System Network
FISU	Food Information System Unit
FOSS	First in Food Analysis
FRAMS	Forage Risk Asessment Managememt System
FUNAN	Fundacion Antisana
GANLAB	Grazingland Animal Nutrition Laboratory
GEF	Global Environmental Facility (World Bank)
GHA	Greater Horn of Africa
GIS	Geographic Information System
GLA	Grazingland Applications
GL-CRSP	Global Livestock Collaborative Research Support Program

GME	Greater Meru Ecosystem
GO	Government Organization
GOK	Government of Kenya
GPS	Global Positioning Systems
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit (German Agency for Technical Cooperation)
ha	Hectare
HPI	Heifer Project International
IA	Integrated Assessment
IARC	International Agricultural Research Center
ICARDA	International Centre for Agricultural Research in the Dry Areas
ICRAF	International Centre for Research on Agroforestry
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IGADD	International Governmental Authority on Drought and Development
ILRI	International Livestock Research Institute
IMAS	Integrated Modeling and Assessment System
IMECBIO	Instituto Manantlan de Ecologia y Conservation de la Biodeversidad
IRGA	Infrared Gas Analyzer
JAINA	Comunidad de Estudios
KARI	Kenya Agricultural Research Institute
KDA	Kenya Rural enterprise Program Development Agency
KFR	Kazakh Fat Rumped Sheep
KFW	Kazakh Fine Wool
kg	kilogram
KTRISB	Kazakh Technological Research Institute of Sheep Breeding
KSBA	Kyrgyz Sheep Breeders Association

Ksh	Kenya Shilling
KWS	Kenya Wildlife Service
KZ	Kazakstan
LDRCT	Livestock Development and Rangeland Conservation Tools (GL-CRSP Project)
LEWS	Livestock Early Warning System
LiTEK	Livestock Marketing in Kenya and Ethiopia (GL-CRSP Project)
LINKS	Livestock Information Network & Knowledge System
LMA	Livestock Marketing Authority
LMSD	Livestock Marketing Services Division
LPAP	Livestock Policy Analysis Program
LPRI	Livestock Production Research Institute
LUCID	Land Use Change Impacts & Dynamics
ME	Management Entity
MoARD	Ministry of Agriculture and Rural Development
MODIS	Moderate Resolution Imaging Spectroradiometer
MRC	Mpala Research Center
NAARI	Namulaonge Agricultural and Animal Production Research Institute
NAFTA	North American Free Trade Agreement
NALRC	National Arid Land Research Center
NARO	National Agricultural Research Organization
NARS	National Agricultural Research System
NCA	Ngorongoro Conservation Area
NDPPC	National Disaster Prevention Preparedness Committee
NDVI	Normalized Difference Vegetation Indices
NFE	Non-formal Education
NGO	Non-Governmental Organization
NIRS	Near Infrared Reflectance Spectroscopy

NOAA RFE	National Oceanographic and Atmospheric Administration Rainfall Estimate
NPP	Net Primary Productivity
NREL	Natural Resource Ecology Laboratory
NRRC	National Range Research Center
NSF	National Science Foundation
NUFFIC	Netherlands Organization for International Cooperation in Higher Education
NUTBAL	Nutritional Balance Analyzer
OADB	Oromia Agricultural Development Bureau
OARI	Oromia Agricultural Research Institute
OAU-IBAR	Organization of African Unity -- Interafrican Bureau for Animal Resources
OCPB	Oromia Cooperative Promotion Bureau
OFDA	Office of Foreign Disaster Assistance
OPDC	Oromia Pastoral DevelopmentCommission
ORP	Outreach Review Panel
OSCE	Organization for Security and Cooperation in Europe
PAC	Program Administrative Council
PAR	Photosynthetic Active Radiation
PARIMA	Pastoral Risk Management Project (GL-CRSP)
PCDP	Pastoral Community Development Project
PDA	Pond Dynamics/Aquaculture CRSP
PHEWS	Plant Health Early Warning System
PHYGROW	Plant Growth/Hydrology/Yield Simulation Models
PI	Principal Investigator
PISP	Pastoralist Integrated Support Program
PLAN	Community Planning for Sustainable Livestock-Based Forested Ecosystems in Latin America (GL-CRSP Project)

POLEYC	Integrated Assessment of Pastoral-Wildlife Interactions in East Africa (GL-CRSP Project)
PRA	Participatory Rural Appraisals
RCMRD	Regional Center for Mapping of Resources for Development
REDSO	East African Region USAID
RMA	Risk Management Agency
SANREM	Sustainable Agriculture and Natural Research Management CRSP
SARDEP	Sustainable Animal and Range Development Program
SCT	Spatial Characterization Tool
SDP	Stochastic Dynamic Programming
SE	Socio-Economic
SEMARNAP	Servicio Nacional del Medio Ambiente, Recursos Naturales y Pesca
SEYE	Managing National Parks in the Context of Changing Human Populations and Economics (GL-CRSP Project)
SLLPC	Sustainable Livelihoods for Livestock Producing Communities
SM	Sierra de Manantlán
SMBR	Sierra de Manantlán Biosphere Reserve
SMS	Short Message Service
SNV	Netherlands Development Organization
SORDU	Southern Rangeland Development Unit
SPAN	Strengthening Partnerships with National Agricultural Systems
SPARE	Strategic Partnership for Agricultural Research & Education
SUMAWA	Sustainable Management of Watersheds: The River Njoro, Kenya (GL-CRSP Project)
T	Temperature
TANAPA	Tanzania National Parks
TAMU	Texas A&M University

TCP	Technical Cooperative Program (FAO's assistance Program)
TDS	Total Dissolved Solids
TE	Terraneuva
TK	Turkmenistan
TLU	Total Livestock Unit
TM	Thematic Mapper
TME	Tarangire/Manyara Ecosystem
Tot-N	Total Nitrogen
Tot-P	Total Phosphorous
TSS	Total Suspended Solids
UCD	University of California, Davis
UdG	Universidad de Guadalajara
UNDP	United Nations Development Program
UNEP	United Nations Environmental Program
USAID	United States Agency for International Development
USDA ARS	United States Department of Agriculture Agricultural Research Service
USGS	United States Geological Survey
USU	Utah State University
UT	Utah
UW	University of Wisconsin
VOCA	Volunteers in Overseas Cooperative Assistance
VSF	Vétérinaires Sans Frontières
WB	World Bank
WEAP	Water Evaluation & Planning System
WFP	World Food Programme
WHO	World Health Organization
WINISI	Win Inservice Inspection Software

WMO	World Meterological Organization
WPL	Webb, Pearman, Leuning Equations
WTO	World Trade Organization
WXGEN	Weather Generator for EPIC
YNP	Yellowstone National Park