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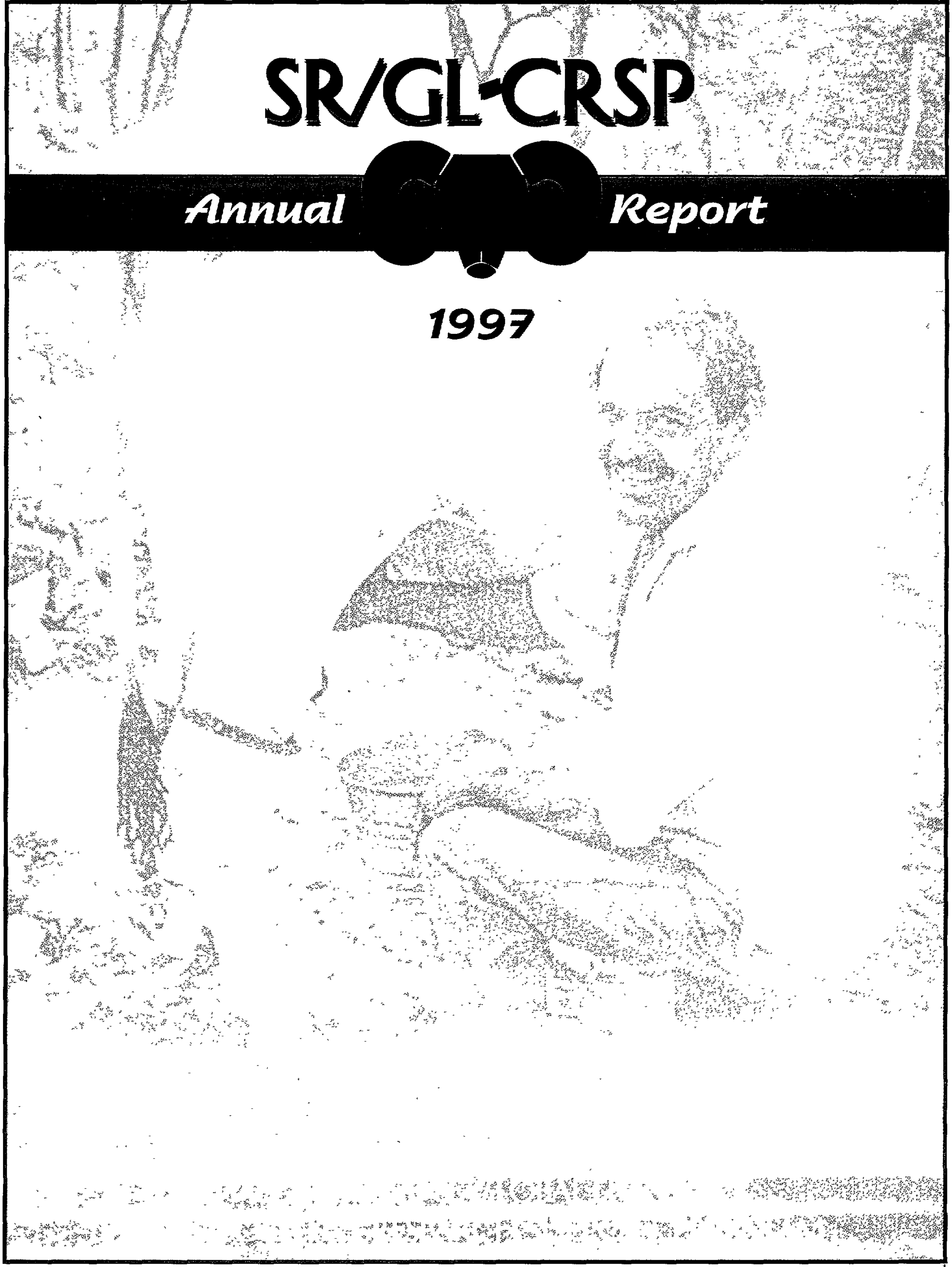
SR/GL-CRSP

Annual Report

1997



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Small Ruminant Global Livestock CRSP Annual Report 1997

Edited and Designed by Susan L. Johnson
Maps by Katherine Lui
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Cover Photo : Small landholder Gerardo Romero milks his cows in the forest in the Ejido of Zenzontla in the Sierra de Manantlan Biosphere Reserve in Mexico. Through a participatory community approach, the *Livestock-Natural Resource Interfaces* project has established grazing plots and exclosures on his land. Team members are doing follows of his cattle to determine the cows diet in the forest and the vegetation impact. Photo courtesy of Dr. Timothy Moermond.

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PREFACE

Each year, the Small Ruminant Collaborative Research Support Program (SR-CRSP) publishes an annual report in compliance with grant requirements. This annual report covers the last year of the Kenya SR-CRSP component and the results of the assessment team process in Central Asia, Latin America and East Africa. The closing research performed in Kenya covers the period January 1, 1997 through September 30, 1997, while the nine-month assessment process was October 1, 1996 through June 30, 1997. The principal investigators for each project submit reports on research conducted with SR-CRSP funding. Each report is the expression of the principal investigator with grammatical and format 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.

A special thanks to Araceli Cortez, Tara Foster and Katherine Lui who have been of invaluable assistance in the production of this document.

Susan L. Johnson
Annual Report Coordinator

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FOREWORD

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Over the last two years, while supporting ongoing programs in Indonesia, Bolivia and Kenya, the Small Ruminant/Global Livestock Collaborative Research Support Program (SR/GL-CRSP) has re-engineeered itself to become a more efficient and effective program. In the process, a comprehensive planning and assessment procedure which consisted of: three major regional conferences which set program priorities in East Africa, Central Asia and Latin America; the selection of 11 assessment teams (ATs); the organization of over 20 regional workshops for grass roots input; an extensive interactive process to develop results-oriented project proposals; and an objective and diversified process to insure that the very best projects were developed.

Regional Workshops

At the beginning of 1996, the SR/GL-CRSP organized a workshop in the each of the three regions selected for activities. The organization of regional workshops was designed to identify and prioritize potential areas for research and development. 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. To do this, they developed problem models to establish the scope for activities within the region. Each workshop was held in collaboration with a regional organization active in the region. The SR-CRSP teamed with the Association for Strengthening Agricultural Research in East and Central Africa (ASARECA) in East Africa, the International Centre for Agricultural Research in the Dry Areas (ICARDA) and the Uzbek Academy of Sciences in Central Asia, and the Interamerican Institute for Cooperation in Agriculture (IICA) in Latin America. Workshop participants included representatives of individual countries, universities, national agricultural research systems (NARS), IARCs, NGOs, the private sector, and USAID.

Assessment Teams

Throughout 1997, input into program planning at the grass roots level was solicited through the activities of assessment teams organized to investigate problems identified at regional workshops. The problem model was the central component of the assessment process, each model representing one of a set of regionally-identified problems developed by workshop participants. Ten assessment teams were funded to compete amongst themselves for full research and development support. Competing with these teams was also a regionalization project from one of the ongoing CRSP projects. Assessment teams were charged with refining their problem model through in-field explorations and selection of additional team members appropriate to the demands of the problem. The results of the iterative process for problem model development and team building is presented in this publication.

Project Implementation

At the end of 1997, the SR/GL-CRSP selected seven projects for continuation. While all assessment teams were considered worthy of selection, funding limitations restricted the number of full projects that could be continued. The projects funded involve 13 U.S. universities, five international agricultural research centers, and 69 foreign institutions including 17 non-governmental organizations. These projects are linked into regional and global programs addressing the most important topics in the international livestock development sector.

Global Themes

In the re-engineering process four areas of focus were developed, with global implications. The four areas are linked by a theme of agriculture at risk in a changing environment. First, economic growth in animal agriculture is considered critical to the economies and social and political stability of developing countries. Agriculture is a dominant component of these economies, contributing 40% of the Gross Domestic Product (GDP) and livestock represents 27% of agricultural GDP (FAO 1996). Establishing strong capacity to participate in global markets, yet maintain food security at the household level is an objective of the SR/GL-CRSP and because of the consistent importance of livestock worldwide, this focus has global implications.

Second, achieving economic growth and food security while maintaining and enhancing biodiversity and natural resources is a critical balancing act with major consequences for developing countries. Not only does crop agriculture, generally and livestock grazing specifically, use vast quantities of the land (estimates are that one-half of the earth's land surface is grazed (Durning and Brough 1992)), its impact has often been in conflict with the maintenance of biodiversity. Estimates by the United Nations Environment Program (UNEP) indicate that 73% of the world's 3.3 billion hectares of dry rangeland is at least moderately desertified, having lost 25% of its carrying capacity. This conflict is apparent in East Africa. Here the CRSP has a project where some of the most valuable diversity of large mammals (tourism in Kenya and Tanzania annually earn $400 M and $258 M respectively) sits in juxtaposition to areas of high potential for agriculture in a region straining to feed its populations. The need for compatability in livestock and conservation systems is a world-wide challenge with some timely examples in our own national parks such as Yellowstone where domestic and wild species are in direct conflict. The value of eco-tourism worldwide in 1994 is estimated at $166-250 billion and for wildlife $83-166 billion (Ecotourism Society 1998).

Third, human nutrition and particularly child survival and development (both cognitive and physical) are a global issue. The malnutrition observed today in children will be a legacy of reduced creative and cognitive function that slow the ability of countries to compete in the global market, solve their domestic problems and develop their national capacity to develop themselves. The World Bank estimates that the costs of micronutrient malnutrition are 5% of GDP for developing countries (World Bank 1994). The link between micronutrient deficiencies and child development and survival is emerging as a major theme in development. Animal source foods (ASF) are an effective, efficient and sustainable means to remove the major deficiencies. The problem is malnutrition affects 840 million people or approximately one-half the world's population (Combs et al. 1996). An estimated 2 billion people live at risk of disease resulting from deficiencies in vitamin A, iodine and iron (major sources of vitamin A and iron are ASF). Iron deficiency, linked directly to cognitive development and achievement, is the most prevalent micronutrient deficiency affecting 2.1 billion people, mostly women of reproductive age and pre-school children.

Fourth, globalization has a major impact on policy for developing nations. A comprehensive analysis of the development of national economies indicates that in Africa the role of policy is critical to the growth of agriculture (Cleaver and Donovan 1994). The SR/GL-CRSP approach considers the policy environment to be equally as important to development as the biological and physical environment. Because national agricultures are faced with increasing exposure to global forces, issues of agricultural growth at the local, national and regional level must incorporate new policies. The interaction of livestock and the environment and the protection of biodiversity require a coupling of information and projections with appropriate policy reform to be successful (WRI, ICUN and UNEP 1992). The changes from central controlled, command to market economies in Eastern Europe and Asia represent a major pertubation in the policy environment to which agriculture must respond.

Since the legislation of Title XII of the International Development and Food Assistance Act of 1975, significant progress has been made in addressing the problem of food production. Nonetheless, malnutrition and famine persist, and projected population trends threaten to undercut what progress has been made. However, increasingly significant is the fact that increased aggregate production of food does not guarantee alleviation of hunger and malnutrition. Beyond problems of the production and distribution of food, resource-poor families lack the incomes needed to purchase or produce food. In this respect, livestock production has multiple advantages, as it increases both the overall supply of food and the incomes of small producers. Inasmuch as animal agriculture is a dominant sector of developing country economies, improved livestock production can have a dramatic impact on the growth of the agricultural sector. Since accelerated agricultural growth has been shown to boost the economy, the importance of animal production to overall economic growth should be carefully considered.

In addition to playing multiple and varied roles in agricultural production, livestock also supply a quality food. Recent studies have shown that not only the quantity but also the quality of food consumed is critical. Animal source foods supply micronutrients essential to human cognitive and physical development. Lack of micronutrients can result in birthing complications among pregnant women, impaired cognitive and behavioral performance among preschool and school-age children, and reduced work capacity among adults in general. The enhanced production of livestock, as both a source of food security and increased incomes and as a distributional mechanism for crucial micronutrients, can contribute substantially to human well-being and equity in resource-poor countries. Because of the extent of this deficiency in many developing countries, the loss of cognitive capacity at the population level is likely to be a major constraint on these country's ability to develop themselves.

The importance of animal agriculture to overall economic growth, to the vast use of land and to human physical and cognitive development brings into perspective the need to study the differential impacts of livestock production on the environment. As livestock grazing is the principal use of land globally, its management has major implications for biodiversity maintenance. The protection of biodiversity and the natural resource base upon which production depends requires the development of environmentally-sound food production systems. The demands of economic growth and human nutrition, on the one hand, and of the environment, on the other, are countervailing tendencies that need to be studied in tandem to prevent systemic inbalances.

Dimensions of Livestock-Centered Development

As the Small Ruminant/Global Livestock CRSP prepares to enter the twenty-first century, there is an increased awareness of the complexity of international research and development. To address the many dimensions of livestock-centered development, broad-based interdisciplinary and collaborative undertakings are crucial. The past two years have witnessed a process of focused change and institutional reorganization which demonstrates the readiness of the redesigned CRSP to undertake the challenges of the coming century.

Central to the new approach is a multi-dimensional model capable of embracing the multiple aspects of the development problem. This problem model, representing the new SR/GL-CRSP approach, serves to focus different disciplinary perspectives on the single issue of development through enhancements to animal agriculture. It is a three-dimensional model with the three axes representing economic growth, human nutrition, and environmental integrity, respectively. Previously, the work of CRSPs focused narrowly on economic growth and production. New knowledge and decades of experience have revealed the multifaceted nature of agricultural development. This concept underlies both the design of the new CRSP and the process through which it was created.

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Assessment Teams

In October 1996, eleven assessment teams began the nine-month process of team building and problem definition. During the assessment period, the lead U.S. land grant universities completed on-site work to critically examine the problem model and to interview and establish partnerships with other institutions and organizations that would improve the teams' ability to solve the problem and deliver the product. Partnerships were established with NARs, IARCs, NGOs, grass root farmer's and women's organizations and private sector organizations. The intention of the assessment period was to allow collaborative relationships to be built in the planning stages of the development project, based on a more complete understanding of the research/development problem.

Central Asia

GIS Modeling Tools for International Donors and Local Policy Makers to Understand and Predict Regional Trends of Rangeland Production in Central Asia

Principal Investigator: *Emilio Laca, Agronomy and Range Science, University of California, Davis, California 95616. Tel: 530-754-4083, Fax: 530-752-4361, E-mail: ealaca@ucdavis.edu.*

Narrative Summary

Central Asia has endured periods of dramatic political change that impacted all areas of human life and the relationship between humans and natural resources. The latest wave of change that dramatically affected livestock and agriculture in general started in 1991 with the liberalization of prices and privatization of state farms. Unfortunately, the transition to a market economy was started without a coherent plan or support for the producers. This caused imbalances and dramatic reductions of agricultural stocks, production and productivity. We identified a need for coherent policies of transition that include instruments and recommended technological options from which farmers can choose to respond to market signals. The technological options and policies should address problems of extensive livestock production such as lack of forage during winter, improvement of marginal lands previously under small grain production, improvement of herd management and breed selection, and establishment of grazing methods for sustainable range utilization. For the solution to these problems we chose to take an integrated multidisciplinary approach that involves not only on-farm solution of technical aspects, but also a coherent economic assessment of alternatives and policy instruments to support these alternatives. Five areas of study are identified and integrated for the creation and dissemination of technology and for the assessment of policy impacts. Basic natural resources for livestock production will be described and quantified in a GIS. A GIS model of forage production in the major ecological regions of Kazakhstan, Uzbekistan and Turkmenistan will be based on continuous measurements of CO_2 fluxes. This model will be used to construct scenarios of seasonal range production in the different zones, and will provide an assessment of the role of rangelands on global C budget and climate change. Preliminary evidence suggests that rangelands are a major carbon "sink" that attenuates climate change. Confirmation of this role will bring international attention to conservation of Central Asian rangelands. Animal production systems will be described and the main limitations to productivity will be identified. Technological alternatives to remove these limitations, such as increasing livestock nutritional status during winter by supplementation, use

of hay, and reserved forage plots, will be evaluated and demonstrated in farms. Improved grazing methods and small ruminant breeds will be considered. Socio-economic assessment of current and improved production systems will be used to construct a simple economic model to predict productivity and profitability. This economic model will be used to assess the potential impacts of various policy instruments, such as taxes, subsidies and dissemination of technology, under many ecological and forage production scenarios. The information will be developed in cooperation with producers and policy-makers, such that the probability of implementing successful policies is maximized.

Problem Model

Original Goal

Our original goal was to coordinate and enable local research centers to produce a large scale [i.e., low resolution] GIS of rangelands, humans and livestock systems with a novel model to predict rangeland productivity. This goal implicitly assumed that livestock development would be enhanced by making more information available to those involved in decision making. During the assessment year this goal matured and improved significantly as a result of the comments on the original proposal, mid-point evaluation, regional input and team self-evaluation.

Approach

The approach originally proposed to achieve our goal consisted of the following objectives and activities:

- To establish formal links with institutions in Kazakhstan, Uzbekistan, Turkmenistan, Kyrgistan and Tadjikistan.
- To implement fast and reliable communication among all cooperators.
- To prepare the guidelines and uniform standards for the creation of a regional geographic information system (GIS) of rangelands and related resources.
- To identify centers in each country where the GIS work for each republic can be carried out, and to identify a central location where the global GIS model will be assembled.
- To prepare a pilot rangeland-livestock GIS for Kazakhstan.
- To develop a plan for organization of a network of experimental polygons in the main types of rangelands of Central Asia for studies of the dynamics of rangeland production.
- To prepare a preliminary model of rangeland primary productivity based on continuous measurements of CO_2 fluxes and extrapolated on the basis of GIS data.

A regional workshop with wide participation from the region took place in Almaty, Kazakhstan, March 17-22, 1997.

Developments

During the assessment it was determined that a wealth of data on natural resources is available in the region. Most of the data, however, is not in digital form and is under risk of being lost due to lack of resources and rapid institutional changes. These data will be essential for rational planning of livestock development. In spite of the availability of current information on rangeland types, condition and productivity, some data have become obsolete as a direct result of the political and economic reforms. For example, it is not known which wells are currently maintained in the vast network built during the times of the Soviet Union. The changes in production methods and in the organization of livestock production units in the different regions within countries are also unknown. This information will be essential in determining technological options and policy effects on the development of extensive livestock production and rangeland conservation.

The assessment team determined that in order to have significant impacts the goal would have to be updated to include a vertical integration of activities spanning the whole range from research to extension and involvement of policy makers. Part of this decision was motivated by the fact that no formal extension force that can operate under market economy is available in Central Asian countries. The approach was updated to reflect the need to provide technological alternatives for farmers to solve identified technical livestock problems. These alternatives should be backed up by an analysis of their potential impact under multiple policy and production scenarios, and policy makers should be involved in the process of selecting technologies and analyzing the effects of different policy instruments on their performance.

New Goal

Thus, our new goal is to facilitate the development of livestock in Central Asia by identifying the most limiting proximate ecological and socio-economic factors of productivity, testing and demonstrating alternative low-cost technologies, and by creating a GIS tool to explore the potential results of selected technologies and livestock development policy instruments.

Current Problem Model

The transition to a market economy was started without a coherent plan or support for the farmers. This caused imbalances and dramatic reductions of agricultural stocks, production and productivity. We identified a lack of planning and a need for coherent policies of transition that include instruments and recommended technological options from which farmers can choose to respond to market signals. This general problem had specific consequences that posed technical livestock problems. For the solution to these problems we chose to take an integrated multidisciplinary approach that involves not only on-farm solution of technical aspects, but also a coherent economic assessment of alternatives and policy instruments to support these alternatives.

The following specific technical limitations to livestock production and livestock development were identified:

- Imbalance between forage resources, livestock and population. Rangeland carrying capacity for the current technology has been reached or exceeded. Lack of winter forage and fuel leads to overgrazing and gathering of shrubs that will devastate forage resources for a long time. The gathering of forage and fuel by hand is one of the most typical causes of severe desertification.

- Development of improved pastures in marginal lands formerly used for small grain production (10^7 ha in Kazakhstan and Kyrgystan). This should increase the grazing capacity of the region by 20% and would dramatically reduce wind and water erosion problems.
- Large-scale unevenness of distribution of grazing pressure results in low production efficiency and rangeland degradation. Continuous grazing has resulted in degradation of rangeland condition and reduction of productivity.
- Lack of maintenance of wells reduced the area of land available for grazing.
- Lack of low-cost technological alternatives from which producers can choose to respond to market signals.
- Insufficient productivity for farms to survive as input prices increase and output prices decrease as a result of liberalization of markets. Productivity of livestock is low and declining as a result of lack of capital and management options to deal with economic changes. Flock management and breeding practices should be reviewed.
- Unknown situation of livestock production enterprises and systems. Land tenure system is in rapid flux.
- Improved herd composition to maximize the efficiency of the herd as a whole; proper culling practices; changes in breeding and management practices to meet market requirements; consider meat, wool or karakul sheep as alternatives.

Technology will be demonstrated in farms and research stations, and disseminated through Ministries of Agriculture, NARS, Agricultural Universities, and Farmers Associations.

Developmental Relevance

Sustainable development of livestock in Central Asia depends on the dissemination of alternative technologies that will allow producers to capitalize and respond to markets. Because of the current regional situation, adoption of technologies will depend on government support effected by specifically tailored policy instruments. We plan to study and generate alternative technologies to deal with the most limiting production factors, such as lack of winter forage, to disseminate and demonstrate these technologies to producers, and to involve policymakers in the analysis of potential effects of different policies under various production scenarios. If successful, this approach will be an example for larger efforts in the region.

Assessment Team Process and Progress

Overview of Proposed Activities and Progress

To establish formal links with institutions in Kazakhstan, Uzbekistan, Turkmenistan, Kyrgistan and Tadjikistan. We established contacts with numerous individuals and institutions from the region. As reflected by the current team membership, we will emphasize work in Kazakhstan, Uzbekistan and Turkmenistan.

To strengthen contacts with Central Asian scientists involved in rangeland and livestock research through the seminar organized by the Overseas Development Institute (ODI). Dr. Thomas Nordblom attended the seminar and represented our group. Dr. Carol Kerven of ODI became involved in the assessment.

To implement fast and reliable communication among all cooperators. In progress. A complete computer system was installed at the headquarters of the Institute of Ecology and Sustainable Development in Almaty. This computer was matched by the Institute with a series of terminals and is being used as the server for the GIS work. Compatible drives and modems were delivered to scientists in the Karakul Husbandry Research Institute and the Institute of Land Tenure. Funds were provided to pay for the costs of electronic mail and fax communications. Communication with the region is still difficult, but improving. We expect that full internet access will be commercially available very shortly.

To prepare the guidelines and uniform standards for the creation of a regional geographic information system (GIS) of rangelands and related resources. Dr. Richard Plant became part of the team to work on the GIS aspects. The IDRISI software was selected for the system and licenses were distributed among cooperators.

To identify centers in each country where the GIS work for each republic can be carried out, and to identify a central location where the global GIS model will be assembled. A regional center should not be selected yet, until the membership and organization of the final team is clearer. This decision is based mostly on the finding that institutions in Central Asia are in a state of rapid change, and that significant tensions exist among many of these institutions. All collaborators will have access to the data which will be maintained at the GIS lab at UC Davis.

To prepare a pilot rangeland-livestock GIS for Kazakhstan. The necessary maps have been obtained. Under the lead of the Institute of Ecology and Sustainable development, most of the proposed layers have been digitized. These layers include vegetation types; grassland zoning by season of utilization; average forage productivity map; genetic soil classification; soil texture map; map of soil structure; annual precipitation (by seasons); average and minimum January temperature; average and maximum July temperature; and solar radiation. Information on small ruminant numbers (goats and sheep), large herbivore numbers (horses and camels) and human population is available but at much lower resolution. Considering the short time and the vast area covered by Kazakhstan, this pilot GIS is a significant accomplishment and a positive indicator of the feasibility of the proposed project.

To develop a plan for organization of a network of experimental polygons in the main types of rangelands of Central Asia for studies of the dynamics of rangeland production. Three main rangeland types were identified: "Northern" shrub rangelands, mostly dominated by *Artemisia herbae-albae* (with two subtypes: grass-sagebrush semidesert and northern sagebrush desert); "Southern" shrub rangelands (with two subtypes: ephemero-sagebrush deserts on mostly loam-clay soils and shrub sandy deserts, mostly *Haloxylon persicum* communities on sandy soils); Foothill rangelands (with two subtypes: grass-ephemeral-sagebrush deserts, and ephemeral -grass deserts/semideserts, mainly *Carex pahystilis - Poa bulbosa* communities).

To develop a novel model of rangeland productivity based on CO_2 flux measurements. The CO_2 flux measurements obtained in the 1996 growing season (April to October) from the Bowen ratio energy balance technique were processed, and a manuscript is being prepared for submission to a refereed journal (N.Z. Saliendra, D.A. Johnson, and J.W. Walker). Measurements from the Bowen ratio technique provided both daily and seasonal measurements of net ecosystem fluxes. During photosynthetically active months (May to August) when PAR was high and soil moisture was available, significant ecosystem CO_2 uptake prevailed during the day, whereas CO_2 efflux occurred at night. Thus, CO_2 fluxes were separated into day (Fday; photosynthetically active radiation, PAR>0) and night (Fnight; PAR<=0) periods, and integrated for each period within a 24 h daily cycle. Daily net ecosystem CO_2 flux (Fnet) was calculated as the sum of Fday and Fnight. Integration of daily Fnet throughout the year will provide an estimate of annual net primary productivity (ANPP) of the ecosystem. Thus, semi-empirical models could be developed and parameterized from CO_2 flux data as driven by micrometeorological factors (e.g., PAR, soil temperature and moisture, atmospheric humidity, etc.) and vegetation indices (e.g., above-ground biomass, leaf area, normalized difference vegetation index). Nonlinear functional relationships of the day-time and night-time fluxes were identified for the sagebrush steppe ecosystem in relation to photosynthetically active radiation (PAR), air temperature (Tair), soil temperature (Tsoil), relative air humidity (RH) and soil moisture (Wsoil). These relationships were used to perform diurnal integration of CO_2-flux rates to obtain daily values of day-time and night-time flux integrals, total net daily carbon exchange of the ecosystem (g C m^{-2} d^{-1}), and seasonal net carbon exchange between the ecosystem and external atmosphere (g C m^{-2} $season^{-1}$). The matrix of the daily aggregated values of carbon flux rate components (Fday, Fnight, Ftotal, g C m^{-2} d^{-1}) were combined with daily averages of the main driving environmental factors (PAR, Tair, Tsoil, Wsoil, RH, and others) for subsequent analysis. Multivariate analysis of the daily aggregated matrix demonstrated that predictive equations for estimation of nighttime ecosystem respiration could be constructed to predict expected respiration rates as a function of soil temperature and moisture. Relationships of total daytime carbon flux from the atmosphere to the sagebrush-steppe ecosystem with total daily PAR, average soil temperature, air humidity, and soil moisture were also established. To produce predictive equations for estimation of daytime carbon fluxes, it was necessary that these environmental drivers be combined with vegetation characteristics such as green aboveground biomass (Bgreen), leaf area index (LAI), or normalized difference vegetation index (NDVI). Because environmental drivers (PAR, Tsoil, Wsoil, etc.) and vegetational parameters (Bgreen, LAI, NDVI) may be estimated for large geographical areas using a ground-based measurement network and/or remotely sensed measurements, the aggregated carbon flux models can be used to scale up results of local carbon flux studies to wider geographical areas, for which the GIS data will be used.

Future Activities

Basic Resources and GIS (BR)

Leaders: Richard Plant, GIS, UC Davis; Eddy De-Paw, basic resources, ICARDA; Ludmila Shabanova, basic resources, IESD-RK. ***Other members/contacts***: Kurochkina, Andrusevitch, Lebed, Zakarin, Turbacheva, Podolskiy.

Objectives and Activities

This group will be in charge of collecting all of the information and building the GIS part of the project. The key layers will be: digital elevation map; vegetation type; grassland zoning by season of utilization; average forage productivity map; genetic soil classification; soil texture map, or at least percent of sand in top soil layer); map of soil structure; annual precipitation (by seasons); average and minimum January temperature; average and maximum July temperature; solar radiation; small ruminant numbers (goats and sheep); large herbivore numbers (horses and camels); human population, including rural population; phytoreclamation maps.

In addition, we may build a layer with the current distribution of watering holes for livestock. It is not necessary to record the exact location of each watering point but just a quantitative estimate of the availability and salinity of water available for livestock with a minimum resolution of approximately 10x10 km. This layer will be essential to identify areas that produce forage but are not grazed due to lack of water (link with RF). Other layers could be transportation network (link with SE), potential elemental deficiencies in forage (link with AP), and animal densities (link with AP).

This group will explore the possibility of updating the dynamic layers by using satellite data from the Space Research Institute, led by E. Zakarin. There may be a potential for doing a unique analysis of remotely sensed data by pairing the databases of the Institute of Land Tenure, led by L. Podolskiy (ground data) and the catalog of images kept by the Space Research Institute.

Range Forage Capacity and CO_2 (RF)

Leaders: Doug Johnson, CO_2 and forage production, USDA; Tagir Gilmanov, range ecosystem modeling, South Dakota State University; Gustave Gintzburger, range and forage production, ICARDA; Mukhtar Nasyrov, range forage production, Uzbekistan. ***Other members/contacts***: Saliendra, Grishenko, Zakarin, Babaev, Sidorenko, Mukhtar Nasyrov, Laca.

Objectives and Activities

This group will be in charge of preparing a model to predict rangeland productivity (ANPP) on the basis of novel measurements of CO_2 fluxes. Basic GIS layers with rangeland classification and weather parameters etc. will be used as a basis to extrapolate the model predictions (link with BR). The global productivity model of the GIS will be based on the novel experimental protocol developed by the USDA-ARS CO_2 flux measurement network, as currently applied by the Forage and Range Research Lab in Logan, Utah (Held et al., 1990, McGinn and King 1990). This work is based on the establishment of polygons on different rangeland sites where a series of causal factors and CO_2 exchange are measured. Studies on the polygons will include measurements of plant biomass, production and gas-exchange dynamics supplemented by ground meteorological and management records, and coupled with remote sensing information from aircraft and satellites. Both phenomenological (statistical, correlative) and dynamic simulation modeling techniques will be applied to the data to construct predictive models for estimation of net primary production and forage production of different rangeland types. Combined with GIS and using appropriate climate change and human management scenarios these models may be used by decision makers as a tool for defining management strategies that combine livestock production to satisfy the needs of the growing human population and preservation of sustainable rangeland production.

The output of this group will be integrated with the results of AP as a diagnostic tool to identify over and understocked areas. The potential for increased production by a better spatial match between stocking rates and ANPP can be estimated. This group will work in coordination with TA and BR to determine what areas have the greatest potential for successful extensive pasture improvements, such as seeding of shrubs, etc. Activities will involve measurements of CO_2 fluxes in a variety of rangelands and conditions to give generality to the model. This group will also elaborate on the role of rangelands in the US and Central Asia in the global C budget and climate change.

Examples of activities on which the group can focus: (a) Artemisia terra-alba was identified as a keystone species in the arid areas between Almaty and Lake Balkash. This species is a preferred productive forage that tends to disappear under excessive grazing. There appears to be a threshold plant density below which the plant community does not recover, regardless of management. This threshold has to be defined quantitatively and can be used by TA to devise grazing management schemes that allow recovery of productivity and that are consistent with the resources available to livestock owners and with land tenure conditions. Susceptibility of A. terra-alba and other shrubs to intensity and timing of grazing can be studied in collaboration with TA. (b) Comparison of C fluxes and balances in areas of rangeland in poor and good condition. The results can be used to lobby for improved rangeland management and political emphasis on livestock production as a more benign type of land use than agriculture that also has a better comparative advantage.

Animal Production (AP)

Leaders: Emilio Laca, grazing ecology, UC Davis; Euan Thomson, animal nutrition, ICARDA; Ovlyakuli Hodjakov, animal breeding, Turkmenistan. ***Other members/ contacts***: Aripov, Egenbayev, member from Kyrgystan to be identified.

Objectives and Activities

In coordination with SE, this group should identify and characterize typical animal production and grazing systems in the main ecological regions. These systems should be described quantitatively by technical coefficients for the different production stages (e.g., lambing rate, herd composition, mortality rates and causes, productivity of forage, meat and fiber per unit land and animal, composition and prices of inputs and outputs, source of inputs and destination of products). Much of the information may be obtained from the literature published or may be obtained by interview/survey techniques. On the basis of a comparative and causal analysis of indices of productivity, limiting processes to be addressed by TA will be identified. For example, farm observational studies can be carried out to determine if a low lambing rate is due to poor ovulation, poor breeding, poor pregnancy rates, or excessive mortality. Each stage can be linked to specific causes such as poor choice of breeding season, nutrition prior to breeding, poor nutrition immediately prior to lambing, etc. It is expected that systems and problems will differ between regions. A second objective for this group is to determine stocking densities and grazing animal populations to be incorporated to the GIS (link with BR). This may be accomplished by direct spatial sampling or by development of a new technique (remote sensing?) if feasible.

Technological Alternatives (TA)

Leaders: Emilio Laca, range management, UC Davis; Mekhlis Suleimenov, pasture improvement and extension, RK; Kasim Asanov, pasture improvement, RK. ***Other members/ contacts***: Abdraimov, Hodjakov, Kerven, Nordblom, Zhambakin, U. Nasyrov.

Objectives and Activities

The objective of this group will be to experimentally explore and demonstrate alternative management schemes, range improvements, herd management options, etc., specifically designed to reduce the limitations to productivity identified by the other groups (links with RF, AP and SE). Experiments should be designed and carried out in locations that allow an educated extrapolation of results to similar areas (link with BR). The activities should include an extension component, even if it is of limited scope. For example, experimental implementation of some simple new technologies in farmers herds and lands should be considered. On the basis of the simple models of production units constructed by AP and SE, this group can explore the potential for different improvements before they are actually tested experimentally. For example, technological alternatives to consider can include:

- seasonal-suitability and rest-rotation grazing methods;
- different improved pastures seeded in marginal agricultural lands formerly used for small-grain production;
- winter feeding options such as fenced forage-reserve plots, supplementation with grains, importation of hay, etc.;
- fencing of private land to attain exclusive and rational range use (carefully considering the potential consequences of widespread use of fences beforehand).

Socio-economic Aspects, Land Tenure and Policy (SE)

Leaders: Lovell Jarvis, livestock development, UC Davis; Tom Nordblom, livestock economics, ICARDA; Lev Podolskiy, economist, RK. Other members/contacts: Kerven, Laca, Kreshnik, Khusanov.

Objectives and Activities

This group will describe production systems along ecological and economic gradients and/or in a variety of subregions. The first goal of this group will be to outline how the whole project can and will be used to promote policies for livestock development. For example, one of the objectives could be to perform an analysis of the potential effects of different policy instruments such as taxes, grazing permits, government investments in water and roads, regulation of marketing during times of forage scarcity, promotion of fencing, forage banks, etc. A second goal will be to define the socio-economic environment of the farms or production units in which technologies or policies will have an impact. For example, production units have to be identified and classified on the basis of composition of inputs and outputs, and/or on the basis of land tenure. These descriptions should be such that they can be spatially interpolated on the basis of the GIS (link with BR) by use of some causal model or spatial sampling. This group should work in close cooperation with RF and AP to define the technological alternatives that should be explored. This group will receive information on weather and rangeland productivity patterns and technical coefficients for different technological options (activities) and ecological regions. A simple LP model will be used to numerically simulate the average and distribution of outcomes for each scenario. The effects of policy instruments will be simulated by perturbations of prices and availability of resources (such as access to grazing lands or improved pastures), and changes in adoption of technology (as would be the result of extension efforts).

Objective 1: Creation and dissemination of alternative low-cost technologies to increase livestock productivity by addressing nutritional and flock management practices such as winter feeding and choice of breeds.

Outputs	Impacts	End User	Actions Required	Team Members	Time
Techniques for improved winter nutrition of livestock.	>10% increase in productivity. Better product quality (e.g., wool) and quantity (e.g., lambing rate). Sustainable use of rangelands.	Private producers and cooperatives. Producers in general, particularly those who produce under extensive conditions.	Literature review of information already available. Selection of promising techniques (e.g., strategic improved forage plots, hay, standing forage reserves, supplementation) to be implemented in demonstration farms and/or tested in experimental stations.	Asanov, Hodjakov, Laca, Suleimenov, Thompson	3 years to obtain multiple-year results. Results available in 2 years. Depends on next output.
Characterization of current extensive production systems and identification of limitations.	Strategic planning of improved technologies, their promotion and dissemination by ministries of agriculture and natural resources.	Producers, cooperatives, Ministries of Agriculture and Livestock Industries, US and regional private businesses that supply inputs necessary to overcome limitations.	Literature review of available information. Field surveys in the three main ecological regions identified. Intensive study of selected production units. Develop classification of systems. Sample areas to derive spatial distribution of systems	Asanov, Hodjakov, Jarvis, Kerven, Laca, Nordblom, Podolskiy, Suleimenov, Thompson	2 years to complete. Information available in first year.
2 PhD's from region	Improved communication between CAR and USA. Dissemination and continuation of project beyond USAID funding	Agricultural institutions of Central Asian Republics (CAR).	Identification of candidates and in-region projects for dissertations. Request applications. Assign projects. Monitor progress.	Gilmanov, Jarvis, Johnson, Laca, Plant, Nordblom. Major professors or advisors.	3 years. Depends on field projects.

Developmental Relevance: The transition to a market economy in Central Asia was started without a coherent plan or support for the producers. This caused imbalances and dramatic reductions of agricultural stocks, production and productivity, as well as rangeland degradation. For the solution of these problems we chose to take an integrated multidisciplinary approach that involves not only on-farm solution of technical aspects, but also a coherent economic assessment of alternatives and policy instruments to support these alternatives. Livestock development will require a large number of processes and changes, many of which are of a very general nature, such as government organization, development of markets and communications, and development of transportation networks. Other necessary changes will be directly related to livestock, such as availability of technological options to respond to market signals, extension of technology, assessment of the rapidly changing livestock and land-use practices, and strategic government interventions that are coherent with a real transition to market economy but that foster the expression of the comparative advantage of extensive livestock production. Two elements will be essential for long-term success in livestock development: strategically planned policies and investments, and availability of alternative environmentally-friendly technologies for livestock producers to create sustainable enterprises. The availability of these technologies, addressed by this objective, is essential for the increments in productivity that will certainly be necessary for livestock production to remain profitable as subsidies disappear and producers are more exposed to international prices.

Objective 2: Assessment and dissemination of potential impacts of alternative policy instruments on production and profitability of different types of livestock enterprises under various weather and technological scenarios.

Outputs	Impacts	End User	Actions Required	Team Members	Time
Expected effects of various policy instruments (taxes, subsidies, investments on transportation or in extension, etc.) on physical production, productivity and profitability of extensive livestock enterprises under various weather and technology scenarios.	Rationally planned livestock development policies. Improvement of productivity and profitability of livestock production. More sustainable enterprises and improved welfare of rural population.	National Centers of Agricultural Research, producers, Federation of Private Farmers, international investors and donors, Ministries of Agriculture and Livestock Industries	Adjust existing LP model (Nordblom) to include activities, constraints, and coefficients determined according to objective 1. Identify alternative policies to be evaluated in cooperation with Ministry of Agriculture. Incorporate ecological scenarios provided by GIS and primary productivity model.	Jarvis, Kreshnik, Khusanov, Nordblom, Podolskiy, Thompson.	1 year since data on production systems and forage production model are available. Depends partially on first two outputs of objective 1 and on all other outputs of objective 2.
GIS with information on basic natural resources for livestock production such as rangeland type, productivity, rainfall, topography, availability of water, etc.	Improved access to information. Facilitated land use planning at government level.	International scientific community. Planning Agencies.	Finish GIS for Kazakhstan and add information for Uzbekistan and Turkmenistan. Provide computers and software for Uzbekistan and Turkmenistan. Train mid-level GIS technicians to digitize and maintain information.	Andrusevitch, De-Paw, Kurochkina, Laca, Lebed, Plant, Podolskiy, Shabanova, Turbacheva, Zakarin.	1.5 years.
Primary productivity model (range forage and CO_2 group). Table of average and variance of range forage production for the 3 main ecological regions identified. Quantification of role of rangelands in capturing atmospheric CO_2.	Improved budgeting of forage resources under uncertainty reduce losses during poor years and prevent widespread degradation of rangelands. Focus on global importance of conservation of rangelands	National Centers of Agricultural Research, producers, Federation of Private Farmers	Establish network of CO_2 measurement stations to calibrate model Coordinate existing network of stations to supply measurements of predictive environmental variables Develop and calibrate model Generate predictions and incorporate into GIS	Gilmanov, Johnson, Nasyrov, Saliendra, Sidorenko, Zakarin.	2 years to obtain measurements in 6 sites and to develop model. 1 year to validate model and to develop primary productivity scenarios. Depends on outputs from the Basic Resources group.

2 PhD's from region	Improved communication between CAR and USA. Dissemination and continuation of project beyond USAID funding	Agricultural institutions of Central Asian Republics (CAR).	Identification of candidates and in-region projects for dissertations. Request applications. Assign projects. Monitor progress.	Gilmanov, Jarvis, Johnson, Laca, Plant, Nordblom. Major professors or advisors.	3 years. Depends on field projects.

Developmental Relevance: As indicated above, two elements will be essential for long-term success in livestock development: strategically planned policies and investments, and availability of alternative environmentally-friendly technologies for livestock producers to create sustainable enterprises. This objective addresses the evaluation of potential impacts of alternative policies and investments to allow an efficient selection of alternatives. This evaluation involves the construction of a regional GIS model that incorporates the typical uncertainty of rangeland forage production, the most basic resource for animal production in the region. This GIS tool will provide information to government, associations and individual producers on what technologies are recommended for different ecological regions and what policies are likely to promote these technologies. In addition, this objective will result in a quantitative assessment of the role of Central Asian rangelands in the global C balance. Global climate change is linked to increases on atmospheric CO_2. Preliminary evidence indicates that rangelands are the "missing" C sink that has prevented steeper increases in CO_2 concentrations. Because Central Asian rangelands are vast, a demonstration of their value in curbing global climate change would result in an international interest on their conservation and sustainable management.

COLLABORATING INSTITUTIONS

Kazakhstan

Karakul Sheep Husbandry Institute
Lenin Square 3, Shimkent
486031 Kazakhstan

Kazakh Research Institute
of Feed and Pasture
Dzhandosov St. 51
480035 Almaty, Kazakhstan
Tel: 3272-214586
Fax: 3272-621757

Institute of Ecology and
Sustainable Development
P/B 86
Almaty, 480100 Kazakhstan

Kazakh Institute for
Hydrometerological Research
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Almaty 480072, Kazakhstan
Tel: 3272-542269
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State Scientific Production
Center of Land Resources
107 Auezov St.
Almaty, Kazakhstan
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Fax: 3272-422927

Institute of Space Research
15 Shevchenko St.
Almaty 480100, Kazakhstan
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Fax: 3272-494355
Email: zakarin@kaziki.alma-ata.su

National Federation of
Private Farmers of Kazakstan
KazAgro Co-op
15 Republic Square
Almaty 480013, Kazakhstan
Tel: 3272-631390
Fax: 3272-630900

(continued next page)

Collaborating Institutions (continued)

Syria

Pasture Forage and Livestock Program
ICARDA, P.O. Box 5466
Aleppo, Syria

Turkmenistan

Institute of Animal Breeding
and Veterinary, Turkmenistan
Gerogly ul., 70
744012 Ashgabad City, Turkmenistan
Tel: 993-12-241127
Fax: 993-12-248994

Uzbekistan

Institute for Market Reforms
Ministry of Agriculture
Samarkand State University
Samarkand, Uzbekistan

United States

University of Califronia, Davis
Agronomy and Range Science
Davis, CA 95616

Utah State University
Rangeland Resources
Forage and Range Resource Laboratory
Logan, UT 84322

United Kingdom

Overseas Development Institute
Portland House,
Stag Place
Victoria, London
SW1E 5DP

Team Member Name	Affiliation	Role/Discipline	Nationality/Residence
United States			
Laca, Emilio A. Principal Investigator, Assistant Professor	Agronomy and Range Science University of California, Davis	Principal Investigator/Rangeland Ecology	Uruguay/USA
Gilmanov, Tagir Professor	Biology/Microbiology South Dakota State University, Brookings, SD	Mathematical modeling/Systems Ecology	American/USA
Jarvis, Lovell S. Professor	Agricultural Economics University of California, Davis	Advisor/Economics of Livestock Development	American/USA
Johnson, Douglas A. Ph.D.	Forage and Range Research Laboratory Utah State University, Logan UT	Primary production/Plant Physiology	American/USA
Kerven, Carol K. Ph.D.	Overseas Development Institute Portland House, London, UK	Advisor/Central Asian Livestock Systems	British/USA
Plant, Richard E. Professor	Agronomy and Range Science University of California, Davis	GIS Expert/Agronomy	American/USA
Saliendra, Nicanor Z. Research Associate	Forage and Range Research Laboratory Utah State University, Logan UT	CO_2 exchange/Physiological Ecology	Filipino/USA
Host Countries and IARCs			
Abdraimov, Seyfulla Deputy Director	Karakul Sheep Husbandry Institute, Shimkent, Kazakhstan	Director of Institute; maps and other data	Kazakstan/Kazakhstan
Asanov, Kasym Director	Kazakh Research Institute of Feed and Pasture, Almaty, Kazakhstan	Forage production, rangeland management	Kazakhstan/Kazakhstan

Team Member Name	Affiliation	Role/Discipline	Nationality/Residence
Host Countries and IARCs, continued			
Gintzburger, Gustave Program Leader	Pasture Forage and Livestock Program, ICARDA, Aleppo, Syria	Coordination with ICARDA/Pasture, Forage and Livestock	French/Syria
Hojakov, Olvyakuli, Director	Institute of Animal Breeding and Veterinary Ashgabat City, Turkmenistan	Animal Production, Turkmenistan representative	Turkmenistan/Turkenistan
Khusanov, Rasulmat, Director	Institute for Market Reforms in Agricultural Sector, Ministry of Agriculture, Uzbekistan	Economics and Policy Studies	Uzbekistan/Uzbekistan
Kurochkina, Lidiya, Ya., Professor	Institute of Ecology and Sustainable Development, Almaty, Kazakhstan	Expert in Central Asian Rangelands/Botanist	Kazakhstan/Kazakhstan
Lebed, Lubov V., Head of Forecast	Kazakh Institute for Hydormeteorological Research, Almaty, Kazakhstan	Weather and Climate	Kazakhstan/Kazakhstan
Nasyrov, Mukhtar, Associate Professor	Samarkand State University Samarkand, Uzbekistan	CO, flux measurements, Forage production	Uzbekistan/Uzbekistan
Nordblom, Thomas L., Ph.D.	Pasture Forage and Livestock Program, ICARDA, Aleppo, Syria	Trends in livestock and feeds/Agricultural Economist	American/Syria
Podolskiy, Lev I., Director	State Scientific Production Center of Land Resources, Almaty, Kazakhstan	Land tenure; ground surveys of vegetation and soils, economist	Kazakhstan/Kazakhstan
Shabanova, Ludmila V., Director	Institute of Ecology and Sustainable Development, Almaty, Kazakhstan	Director of Host Institute; mapping/Ecologist	Kazakhstan/Kazakhstan
Zakarin, Edige Deputy, Director, Professor	Institute of Space Research Almaty, Kazakhstan	Remote sensing, NDVI, GIS	Kazakhstan/Kazakhstan
Zhambakin, Zhapar Director General	National Federation of Private Farmers of Kazakhstan, KazAgro Co-op, Almaty, Kazakhstan	Contact with private farmers, dissemination, advisor on rangeland technology	Kazakhstan/Kazakhstan

The Central Asian Livestock Sector in Transition to a Market Economy

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Narrative Summary

Problem Model 1 for Central Asia seeks to improve the livestock sector through recommendations based on enhanced understandings of how that sector is affected by the transition to a market economy. Numerous interviews with farmers, scholars, government officials, and NGOs during four visits to the region in the past year have led us to focus on the following research priorities: (1) the need to understand the great diversity of new types of farms that are emerging and their different implications for the course of rural development, the distribution of income, and the emergence of stable, democratic societies; (2) the deterioration of marketing and credit services for the livestock sector and the slow emergence of new providers; and (3) the transformation of the critically important sheep subsector toward much greater reliance on meat as the key to profitability.

In addition to identifying research priorities as indicated above, the following accomplishments can be noted for the assessment period: 1. Following meetings and correspondence with research organizations throughout the region, strong collaborators with relevant interests and experience were found in two Kazakh organizations that will play leadership roles in the social science research (the Institute for Oriental studies) and in the animal science research (the Research and Technological Institute for Sheep Breeding). Formal agreements were signed with these organizations. 2. The lead collaborators in the above institutes developed the first draft questionnaire for the field surveys and the initial protocol for the sheep research. 3. Scientists were identified in, and formal agreements were signed with, two other Kazakh organizations that will play advising and consulting roles — the Research Institute for Feed and Pastures and the National Federation of Private Farmers. 4. Commitments of cooperation were obtained from one private US firm, American Breeders Service Global, one international research institute, the International Service for National Agricultural Research, one NGO, Volunteers in Overseas Cooperative Assistance, and one bilateral aid agency, the European Union's Technical Assistance to the Commonwealth of Independent States, and one other CRSP, BASIS. 5. A conference was convened with representatives of all five Central Asian

countries and Russia. Eighteen papers were presented, and a proceedings volume was published. Participants in the conference are potential members of a regional network we plan to establish.

The proposed research has two related components. Field surveys of former state-controlled farms, their employees and members, private farmers, and local and national government officials would be conducted in Kazakhstan, Kyrgyzstan and Uzbekistan in year one, expanding to Tajikistan and Turkmenistan in later years. This would provide core information for policy analysis to assist the emergence of desirable new types of rural organization, marketing, and credit. The surveys would also aid in strategic guidance of research to increase the productivity of sheep meat. The sheep research, starting in Kazakhstan, would increase the number of lambs marketed per ewe by increasing the number of lambs born and surviving per ewe. This would simultaneously improve rural incomes and lower consumer prices while maintaining or increasing the drastically depleted breeding stock and conserving range resources by requiring less feed per kilogram of meat produced.

Problem Model

Problem Model 1, Central Asia: Impact of Decollectivization, seeks to improve the livestock sector through recommendations based on enhanced understanding of how that sector is affected by the transition to a market economy. The assessment period has convinced us that the initial guidelines in the call for proposals and their restatement in our proposal for an assessment grant are largely valid and useful. However, the assessment period has also led to several new understandings and to consequent adjustments in emphasis.

The evolution of the Problem Model (PM) is based on the following new understandings gained during the assessment period: (1) the great diversity of ways in which the new economic reforms and opportunities are being realized in rural areas, and the complexity of factors influencing those changes; (2) the limited public documentation and discussion of this diversity; (3) the dominant importance of credit and marketing constraints; (4) the clear desirability of certain technological advances even in this time of change.

The primary need at this point is to understand and document the many ways that the livestock sector is changing under the transition to a market economy. Throughout the region, most of the farming population still lives and works in former *sovkholzes* or *kolkhozes* that have been renamed cooperative or collective farms, and there is a small but significant development of private "family" farms. Within these two broad categories there is a great deal of diversity. A few examples drawn from farms we visited will illustrate this.

One cooperative farm east of Almaty was functioning as a modern business with its own small dairy processing plant from which it was marketing to stores in Almaty. Another cooperative near Bishkek was operating as a large subsistence farm, bartering with nearby enterprises and paying its members in flour, sugar and milk. A third cooperative west of Almaty had just been "purchased" by the farm manager and two outside individuals, although it is doubtful that any significant payments were made to the member shareholders. This farm was selling some of its milk to a large, modern dairy plant and also marketing some of it direct. A fourth cooperative far north of Almaty in the "desert" zone was rapidly deteriorating, with its public buildings being cannibalized for building materials.

Two private farms were being run by individuals who had left their *kolkhozes* with allocations of land and equipment. The latter included tractors and combines, rather major pieces of equipment to be allocated to individuals. Two other private farms were being run by individuals who had been working in cities and were able to get land allocations. One of the private farmers seemed to have a thriving dairy operation and was seeking to expand. Another was planning to return part of his land allocation to the *kolkhoz* because he could not make a profit on it, even though it was irrigated. One farmer had built a flour mill and sheep dip and was supplementing his farm income with fees collected for milling the *kolkholz's* wheat and for dipping their sheep. Another farmer had specialized in *kumys*, fermented mare's milk, which is the national drink. He was struggling to stay in business. One farmer continued to be a member of his cooperative farm, but also operated privately with a contract from the cooperative farm to raise its heifers.

All these private farms had acquired their land and equipment in different ways. According to the Director of the National Federation of Private Farmers, there have been three phases of privatization, each with different rules. Some who obtained land and equipment under earlier phases have had to fight in court to keep them as new rules were formulated. The rules differ not only over time but they also differ for different individuals. Thus, for example, Kazakh *kolkhoz* managers with more than 15 year's service were allocated 20% of the farm's assets, in addition to other allocations his family might be eligible for. This has allowed some former managers to effectively control these vast enterprises. Others have used the allocation to claim assets that could be easily cashed in, thereby contributing to the sharp decline in livestock numbers. Tractor operators were given tractors and other equipment in some instances.

The above variations were apparent in just the three brief trips we made to Central Asia, with most of the time spent in Kazakhstan. There is likely to be much more diversity that we need to identify, document, and analyze. Existing publications we have seen tend to simplify the situation. Much of the published material discusses cooperative farms and private farms as two fairly homogeneous categories. This may be appropriate for a first snapshot of the region, but a long-term research program that is to generate technological and policy recommendations requires a much more detailed understanding of the various ways that the transition is proceeding in the livestock sector.

Therefore, the first years of the project will place major emphasis on field surveys to gather information about the different ways that livestock enterprises are evolving in Central Asia. This in itself will be a major contribution. In addition, the surveys will help us identify specific research topics that warrant more concentrated work in subsequent years. Two such areas are already evident and will be pursued from the start along with the field surveys.

First, there will be a detailed economic survey of the dairy industry around Almaty, the capital of Kazakhstan. This is an economically important part of the livestock sector, it has major impacts on large numbers of urban consumers, it holds the promise of illustrating a range of variations in the way livestock enterprises are evolving, and it is relatively easily accessible through three processing plants and the central market. In addition, this study will allow us to concentrate on two issues that are critical for the entire livestock sector — credit and marketing.

In many cases, the former state processing and marketing enterprises have either disappeared or operate on shaky grounds and often cannot pay for the commodities they obtain. The dairy industry is a prime case in point. But it is also an industry in which new channels of processing and marketing have been created, including farmers carrying raw milk into the city, a modern multinational processing plant with sophisticated marketing strategies, a former state processing enterprise that is still surviving, and at least one large farm doing its own processing.

The dairy study will also allow examination of the credit problems faced by the livestock sector. Lack of credit was a complaint we heard on private farms and on cooperatives, on dairy farms and on sheep operations. Some had submitted business plans to banks but had no response. Some had been able to get small amounts of credit, but at very high interest rates. Others despaired of getting credit and had not tried. The detailed economic study of the Almaty milkshed dairy industry will complement the broad survey and provide additional information on these two important aspects of the Problem Model, credit and marketing.

The Problem Model has also been modified to focus on technological advances with a strong prospect of addressing the impacts of the transition that can be seen clearly already. The sheep industry in Central Asia has been transformed as the wool market has deteriorated, as pastures have become degraded, as Soviet feed subsidies have disappeared, and as animal numbers have declined precipitously. The result is an industry that now pays much greater attention to meat and must do so in a compromised feed situation. One approach to assisting this industry is to increase the meat productivity of the animals. This can be done by increasing the average number of lambs produced per ewe per year and by increasing the weight gain potential of the animals. Both will mean more efficient use of feed to produce meat.

The Problem Model applies to all five Central Asian countries, but work cannot begin everywhere at once. In the first year, most work will focus on Kazakhstan with one smaller field study in Kyrgyzstan and another in Uzbekistan. Kazakhstan occupies 68%

of area of the five Central Asian countries, it has about 33% of the population, and 45% of the sheep and of the cattle. Its agriculture appears to be at an intermediate stage of transition, not so far along as Kyrgyzstan but ahead of the other three countries.

Assessment Team Process and Progress

Proposed Activities

Our proposal for an Assessment Grant states that,

the proposed assessment program will have two broad dimensions. One will focus on building an iterative, interdisciplinary, participatory approach to (re)define the problem model and design appropriate research strategies. The second dimension will look beyond the research toward building a regional, five-country network that can be a continuing (perhaps permanent) resource to work with policy makers and farmers ....

[The first dimension is] concerned with identifying the key research questions...; locating the best sites...; developing the best methodologies...; and assessing available data sources. [The second is] concerned with identifying key individuals who can contribute to the research and dissemination, developing sustainable mechanisms to maintain the network, and forging partnerships with institutions that can contribute to the network.

We proposed to accomplish these objectives through an iterative process built around repeated visits to the region. Thus each visit would be the occasion for refining the problem model and reassessing the strategy for building a network. The visits to the region were to include farm visits aimed at eliciting farmers' views of their current situation, constraints, and opportunities.

Progress

During the Assessment Period we convened numerous meetings of University of Wisconsin (UW) team members on campus, made three trips to Central Asia and two to Moscow involving five UW team members, acquired official statistical reports, convened a conference in St. Petersburg with papers commissioned from Central Asian researchers, commissioned two national survey papers, and provided three months of Russian lessons for the Lead PI (the Co-PI is a native speaker).

Accomplishments of the assessment period follows:

Identifying Strong Kazakh Research Collaborators

In Kazakhstan we will be working closely with two research institutes and, for the time being, will maintain cooperating relationships with others. The two with which we will be working most closely are the Research and Technological Institute for Sheep Breeding and the Institute of Oriental Studies. We have met with members of both institutes on three separate visits, we have identified lead researchers in each, and these researchers have played major roles in defining the research program.

The sheep institute is considered the leading livestock research establishment in the country. Its Director is a respected member of the Academy, and one of its junior scientists is quite knowledgeable about the latest research on sheep reproduction and genetics. He was recently collaborating with an Israeli scientist with whom the UW sheep expert has also been collaborating. This junior scientist speaks English. He will be the primary collaborator on increasing meat productivity.

The Institute of Oriental Studies is a social science research institute that has studied pastoralism and has now started a whole department devoted to the subject. The new head of that department has a strong research record and is well-known to the UW faculty. He will be in charge of the major field survey program. The Institute of Oriental Studies will also serve as our main coordinating center in Kazakhstan. Its Deputy Director will carry this responsibility. The Institute has a close relationship with the Minister of Science (as evidenced, for example, by their arranging a special Saturday meeting for us with him), and the Director of the Institute sits on a special presidential advisory board. Through the good offices of the Institute we have enjoyed excellent access to and cooperation from a wide range of researchers and research organizations. We have also identified two strong Russian scholars who are experienced experts in Central Asia. One will organize the Kyrgyzstan field survey and the other will organize the northwest Kazakhstan survey. The latter is a woman, and another woman senior scientist will work on the southeast Kazakhstan survey.

Identifying Cooperating Institutions in Kazakhstan

In addition to working closely with the above two collaborating institutions, we will have a loose cooperating relationship with others.

We will maintain a cooperating relationship with the Research Institute for Feed and Pasture. We have met with them during three different visits to Kazakhstan and have enjoyed very good cooperation with the Deputy Director. The Institute is heavily oriented toward rangelands in the semi-desert and desert zones (we visited their station 150 km north of Almaty). We will seek their input into the field surveys, but this will not be so strong a relationship as with the above two institutes.

We will also maintain cooperating relationships with the National Federation of Private Farmers of Kazakhstan, KazAgro. The Director, with whom we have met during two visits and who has accompanied us on three days of farm visits, is very knowledgeable and will be a valuable resource.

We also explored possibilities for cooperation in Kazakhstan with the Institute for Strategic Studies, the Institute of Animal Husbandry, the Agricultural University, the Institute of Ecology and Sustainable Development, and the Institute of the Economy. In Kyrgyzstan we met with individuals from the State University, the Agrarian Academy and the Ministry of Agriculture. We did not judge any of these to be likely strong collaborators. However, during our June meeting with the Kazakh Minister of Science, he recommended that we explore possibilities to cooperate with the Institute of Economy since he had recently ordered them to undertake a farm data collection program that we may find useful. We will pursue this possibility in the future.

Obtaining Major Regional Inputs to Research Design

Following our meetings with the Research and Technological Institute for Sheep Breeding and the Institute of Oriental Studies, each drew up the first draft of the research programs on which we will collaborate. The sheep institute completed this in March, the UW sheep expert developed it further in April/May, and the sheep institute refined that draft in June. The Institute of Oriental Studies developed a full field survey questionnaire and presented it at the June conference. The UW team and other regional collaborators who will be working on smaller surveys in other locations are now in the process of commenting and suggesting refinements. Thus regional researchers have played dominant roles in defining the two major research thrusts we intend to pursue.

Additional input from regional scholars was obtained at the June conference we convened (see below). Central Asian livestock researchers presented papers on the major issues confronting the livestock sectors in their countries, and they also reviewed recent research by their institutes.

Improving our Understanding of Critical Issues for Research

The literature on the economic transition in Central Asia is quite sparse, and documentation on the livestock sector is even more limited. Thus each of our trips to the region was the occasion for significant additions to our understanding of critical issues that might warrant attention in the research project. It was during our trips that we came to appreciate the increasing importance of sheep meat for farm revenues, the disarray of marketing systems for meat and milk products, the dearth of credit for agriculture, and the great variety of ways in which farms are evolving from state control.

The initial research programs designed by our Kazakh colleagues also served to further inform the UW team about key research questions. Finally, our understanding of the issues was enhanced by the papers delivered at the June conference and by surveys of Kazakhstan and Kyrgyzstan that we commissioned from local researchers.

Identifying Cooperating International Institutions

We have identified the International Service for National Agricultural Research (ISNAR), Technical Assistance to the Commonwealth of Independent States (TACIS), and Volunteers in Overseas Cooperative Assistance (VOCA) as valuable cooperating international institutions, and all three have written letters indicating their support. ISNAR has recently received a mandate to begin work in Central Asia. Through correspondence and two days of meetings we have started to define ways of complementing each other's efforts. One of the CRSP's objectives is to strengthen local research institutions, and this is ISNAR's forte. As ISNAR undertakes an assessment of the national agricultural research systems in the region, they will look to us for more in-depth understanding of the subset of institutions with which we work.

TACIS and VOCA are both engaged in hands-on efforts to improve farm enterprises and agribusiness, including those dealing with livestock. We can benefit considerably from their case study experience of individual enterprises. They will look to our results for information on the broader context in which they are operating and for indications of the generalizability of their work. We were able to have repeated visits with both organizations in Kazakhstan, and with VOCA in the US (the US VOCA office responsible for Central Asia is less than a mile from the UW campus).

We also met with the International Center for Agricultural Research in the Dry Areas (ICARDA) and with two British researchers. ICARDA has not yet started a program in Central Asia and suggested that their main value to us would be to convene Central Asian researchers and research institutes. As indicated above, we have been fortunate to have enlisted a local organization to fulfill that role for us. One of the British researchers will not be working in Central Asia, contrary to our initial expectations. The other is awaiting news on funding, and there may be some value in maintaining contact. We have corresponded with a third British researcher who contacted us for assistance with her questionnaire. We will maintain this connection. We spent a day meeting with World Bank personnel and expect to continue sharing information with them.

Gaining High-Level Support in Kazakhstan

The Kazakh Minister of Science, who is responsible for all the research institutes, has met with us to offer his support of the research, and he has given us a letter documenting this. As mentioned above, Minister Shkolnik appears to have a close relationship with our main coordinating institution, the Institute of Oriental Studies, and thus we expect his support to be active and valuable. His recommendation that we explore possible connections with the Institute of Economy is an example. The Ministry of Agriculture has been moving to the new capitol in Akmola, and we have had limited contact with them. Our coordinator in Kazakhstan is seeking a letter of support from the Minister.

Convening Potential Participants of a Regional Network

In June we convened a conference of 15 Central Asian and three Russian researchers. The Central Asians presented papers on (a) the status of their livestock sectors as their countries move toward market economies, and (b) on research at their institutes. These papers will be published in a Russian- language volume and distributed in the region. During the conference, the participants repeatedly remarked on how useful it was for them to hear from their neighbors and to learn of different approaches and experiences. We believe that such sharing will continue to be of benefit, and thus we intend to build it into our work.

One purpose of the conference with commissioned papers was to be able to start assessing the strengths of different individuals and how they might or might not contribute to a regional network. This is an ongoing process. For example, we will see how well we are able to correspond with the participants now that they are back home.

Future Activities

If funded, we would proceed along the following lines: (1) field surveys to learn about the many ways that formerly state-controlled farms are evolving in the transition to a market economy; and (2) a concentrated research and development program to increase the meat productivity of sheep.

In the first year, field surveys aimed at gathering information on a wide range of biological and socioeconomic aspects of the evolving livestock sector would be undertaken in Kazakhstan, Kyrgyzstan, and Uzbekistan. Coverage of the surveys would expand in subsequent years. In addition, results of the surveys will be the basis for selecting additional issues for more detailed study after year one.

The main effort would be in Kazakhstan, with a three-month field program in the newly combined Almaty and Taldykorgan Oblast in the southeastern corner of the country and a one-month field survey in the far northwestern corner of the country in the Uralsk Oblast. A similar one-month, broad-gauged survey would be undertaken in the Chuisk Oblast of Kyrgyzstan. It may be possible to undertake a three-month survey at sites to be determined in Uzbekistan. We would visit Uzbekistan in January to review this. A subcomponent of the Kazakhstan field surveys to be started in the first year would be a detailed study of the economics of the dairy industry in the Almaty milkshed. Similar detailed studies on other issues would commence in subsequent years.

The first draft of the basic questionnaire for all the field studies has been developed by our lead collaborator at the Kazakh Institute of Oriental Studies. He is responsible for the three-month survey in the Almaty-Taldykorgan Oblast. The questionnaire draft is being reviewed by the other collaborators who will use it as they conduct the other surveys, and it is being reviewed by the UW team.

The bulk of fieldwork will consist of questionnaire-guided interviews and observation by regional researchers and their local assistants. Standardized questionnaires will provide comparative data across regions. We would supplement them with informal open-ended interviews.

Key categories of individuals to be formally interviewed are farm administrative personnel (directors, deputy directors, and other managers), farm employees engaged directly in livestock activities, independent farmers (heads of families), women (to understand the gender-related issues), village administrators (i.e., village

Objective 1: Understanding the emerging socio-economic forms of organization among livestock producer

Outputs	Impacts	End User	Actions Required	Team Members	Time to Completion
Research papers, conferences, seminars, policy papers, meetings with policy makers.	Appropriate formulation and targeting of (a) technical assistance; (b) credit; (c) marketing support and policy; (d) and other government policy.	Policy makers, bankers, processing and marketing industries, farmers.	Socioeconomic field research and the follow on publications and meetings.	Social science team members supported by biological scientists.	Three years for phase one.

Objective 2: Increase the meat productivity of Kazakh sheep.

Outputs	Impacts	End User	Actions Required	Team Members	Time to Completion
Sheep with higher lambing rates and larger body size.	Greater meat productivity and more efficient use of animal feed.	Farmers	Breeding program; Improving artificial insemination technology.	Thomas, Malmakov, Medeubekov, Berger, Gottfredson	Three years.

clerks). We will also conduct open-ended interviews with the middle-level managers and administrators in the district centers and with upper-level administrators. The goal is to focus on understanding what these administrators perceive to be their options and preferences for reorganizing livestock activities and why they choose the options they do.

The field surveys would gather information on the current status and ongoing changes in: (1) biological and technological aspects of livestock production; (2) social, economic, gender, legal, and political issues; and (3) management practices and related personal relationship.

The sheep breeding research addresses the need to increase meat productivity in a manner that makes efficient use of limited feed resources. It would do this by increasing the number of lambs marketed per ewe per year and by increasing the size of the animals. The research has the following specific objectives:

- Compare the economic effects of increasing prolificacy in Kazakh finewool sheep by introducing the FecB gene or crossing with prolific breeds.
- Develop effective techniques to freeze ram semen and artificially inseminate ewes with frozen-thawed semen.

The Rambouillet is the major finewool sheep breed in the U.S. It descends from the Spanish Merino so is related to the Kazakh finewool and all other finewool, Merino-type sheep in the world. The Rambouillet has been selected for large mature body size, and would be expected to have greater growth rate but coarser wool than the Kazakh finewool. The University of Wisconsin-Madison has developed a high percentage Rambouillet flock (88 to 97% Rambouillet breeding) that contains the FecB gene of the Booroola Merino. The flock also has been selected for high prolificacy. In this flock, Fec++ ewes have a prolificacy of 1.78, and FecB+ ewes have a prolificacy of 2.46. Body weights of mature ewes are 68 kg. The UW-Madison also has a flock of Polypay sheep with a prolificacy of 1.90 and mature ewe body weight of 70 kg.

The Kazakh Research and Technological Institute of Sheep Breeding (KRTISB) near Almaty has a flock of 10,000 Kazakh finewool ewes at its Mynbaev Experimental Farm with a prolificacy of 1.10 and a mature ewe body weight of 52 kg. At the same location, they have developed a prolific breed that is ½ Kazakh finewool and ½ Finn (Kazakh Prolific) with a prolificacy of 1.70 and mature ewe body weight of 57 kg.

In the early autumn of 1997 and 1998, semen will be collected and frozen from Polypay rams and high percentage Rambouillet rams from UW-Madison. Three to five rams of each breed will be collected. The high percentage Rambouillet rams will be the progeny of high percentage Rambouillet ewes determined to be carriers of FecB (FecB+) and non-carrier Rambouillet rams (Fec++). Each high percentage Rambouillet ram will have a 50% probability of carrying the FecB gene. The frozen semen will be shipped to KRTISB. The high percentage

Rambouillet rams will be genotyped for DNA markers known to be closely linked to the Fec locus.

In October or November of 1997 and 1998, 800 Kazakh finewool ewes at the Mynbaev Experimental Farm will be divided into four groups as similar as possible with respect to ewe age, fleece type, body condition, and previous lambing performance. Two groups of ewes will be naturally mated to either five Kazakh finewool rams or five Kazakh prolific rams in single sire groups. The remaining two groups will be artificially inseminated with either Rambouillet or Polypay semen from UW-Madison.

Successful artificial insemination techniques in sheep that can be used with a minimum of training and equipment are necessary in both the U.S. and Kazakhstan in order to access promising foreign genetics and to move superior genetics within the country. The KRTISB has a group of highly qualified scientists in sheep reproductive physiology with considerable experience in artificial insemination with fresh semen, and UW-Madison has a program in sheep artificial insemination in the early stages of development. Throughout this study, different semen freezing and artificial insemination technologies will be evaluated at both the KRTISB and UW-Madison.

The sheep breeding project uses complementary expertise and resources at both KRTISB and UW-Madison to strengthen the sheep research programs at both institutions and improve the efficiency of sheep production in both countries. UW-Madison has a Rambouillet (high percentage) sheep flock in which the FecB gene is segregating. Rams from this flock with a 50% probability of carrying the FecB gene can be used to introduce the gene into Kazakh finewool sheep. Since the KRTISB has many times the number of ewes than does the UW-Madison, a more accurate progeny test of the rams can be done at KRTISB than at UW-Madison. Rams determined to be FecB+ from the progeny test at KRTISB will be used in the UW-Madison flock to produce FecBB animals. Kazakh scientists at KRTISB have more experience in ram semen collection than do scientists at

Collaborating Institutions

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UW-Madison and can offer their expertise to the improvement of the program at UW-Madison. Similar interests between scientists at both institutions promise to make this project exciting, enjoyable and productive.

Conference Papers

On June 5 - 6, 1997, we convened a conference entitled, "Conditions and Prospects of the Development of Animal Husbandry in the Republics of Central Asia in Relation to the Transformation to a Market Economy." The following papers were presented and will be published.

Abduvasiev, F.S. The Problems and Social Consequences of the Transformation Period in Relation to the Development of Animal Husbandry in Tajikistan.

Abdyrasulov, R.A. Pressing Problems and Perspectives of the Development of Sheep Breeding in Kyrgyzstan.

Alimaev, I.I. The Fundamental Problems of Utilizing Pastures for the Production and Preparation of Feed in Kazakhstan.

Aripov, A.Kh. Astrakhan Fur Production and Arid Feed Production of Uzbekistan: Conditions and Problems of Development.

Dzholdoshev, K.D. The Situation of Pastures and the Problems of Production in Kyrgyzstan.

Dzhumaev, E.B. Contemporary Situation of Animal Husbandry in Kyrgyzstan (A General Overview).

Frank, G. Acquiring Agricultural Inputs in a Transition Economy

Karakulov, A.B. Contemporary Situation of Animal Husbandry in Tadjikistan and its Development under Transition to Market Economy.

Khazanov, A. Mobile Pastoralists in the Contemporary World: Unsolved Problems of Modernization.

Khodzhakov, O. Problems and Perspectives of the Development of Animal Husbandry in Turkmenistan

Masanov, N.E. Peculiarities of the Functioning of the Kazakh Traditional Nomadic Economy.

Medeubekov, K.U. The Contemporary Situation and Actual Problems for the Development of Sheep Breeding in Kazakhstan.

Naumova, O. Economic Perspectives on the Contemporary Situation of Animal Husbandry in Turkmenistan

Shapiro, K. The Livestock Sector in the Transition Economies of Central Asia: A Research Project of the University of Wisconsin and Cooperating Organizations in Central Asia

Soyunova, O. Pastoralism in Eastern Kazakhstan

Usmanov, S-M.N. The Contemporary Situation and Perspectives on the Development of Sheep Breeding in Uzbekistan.

Zhambakin, Zh.A. Problems of Cattle Breeding and the Experience of Private Farmers in Kazakhstan.

Team Member Name	Affiliation	Role/Discipline	Nationality/Residence
United States			
Shapiro, K. Principal Investigator	University of Wisconsin	Ag Economics/Lead Principal Investigator	American
Albrecht, K.	University of Wisconsin	Forage Agronomy	American
Berger, Y.	University of Wisconsin	Animal Science	American
Frank, G.	University of Wisconsin	Ag Economics/Dairy Policy	American
Gottfredson, R.	University of Wisconsin	Animal Science	American
Jesse, E.	University of Wisconsin	Ag Economics/Dairy Policy	American
Khazanov, A.	University of Wisconsin	Socio/Political	American
Thiesenhusen, W.	University of Wisconsin	Land Tenure	American
Thomas, D.	University of Wisconsin	Animal Science	American
Zanca, R.	University of Illinois	Socio/Political	American
Kazakhstan			
Malmalkov, N.	Kazakhstan Institute for Sheep Breeding	Animal Science	Kazakhstan
Masanov, N.	Kazakhstan Institute for Oriental Studies	Socio/Political	Kazakhstan
Medeubekov, K.	Kazakhstan Institute for Sheep Breeding	Animal Science	Kazakhstan
Abuseyitova, M.	Kazakhstan Institute of Oriental Studies	Socio/Political	Russian
Russian			
Klyashtorny, S.	Russian Institute for Oriental Studies	Socio/Political	Russian
Naumova, O.	Russian Institute for Ethnography and Anthropology	Socio/Political	Russian

Latin America

Livestock - Natural Resource Interfaces at the Internal Frontier: Local Community Planning for Livestock and Nature in Latin America

Principal Investigator: *Timothy Moermond, Department of Zoology, 430 Lincoln Drive, Madison, WI 53706, Tel: 608-262-5868, Fax: 608-265-6320, E-mail: tcmoermo@facstaff.wisc.edu.*

Narrative Summary

The vision of this project is to work with local communities in forested mountainous areas in the design and development of a livestock production program for improving people's income and diet, in a manner that is sustainable for the production structure at the family level and the community level and sustainable for the environment (forest, soils, indigenous flora & fauna) at the level of the watershed and the region.

The proposed research will be directed to a process for describing, planning, implementing, and monitoring the integration of livestock into natural forest ecosystems to achieve sustainable production. The context chosen is the interface between agricultural and forested ecosystems in mountainous regions that run throughout Latin America. This interface within nearly every country of Latin America was seen as the "internal frontier": a critical frontier between important watershed source areas and rapidly expanding clearing for logging and agriculture, a frontier as one of the last areas open for colonization by peoples forced to leave resource-poor regions, and a frontier of exploration of the unique rich biological diversity rapidly disappearing in the face of uncontrolled exploitation.

Although livestock are not typically the reason for human colonization of these forested areas and may not constitute the main cause of deforestation and degradation of the land and the water catchment area, livestock are important elements of the problem and the potential solution within these regions. Livestock are often directly associated with modification and/or clearing of natural vegetation as a result of grazing activities. We believe, however, that appropriate management of carefully selected livestock can be ecologically sustainable and can improve the livelihood of the communities in these sensitive regions.

This goal will be approached through the following main steps:

- To study the present and potential role of livestock in the livelihood of rural families and communities.
- To enhance local, community-based planning for the use and management of livestock and for the sustainable use of land and natural resources at the scale of the

community's water catchment area.

- To work with rural families and communities in the development of sustainable, alternative uses of livestock and natural resources.

The methodological spirit for program design and implementation is both interdisciplinary and participatory. Knowledge, expertise, and process are to be drawn from different biological and social science perspectives from universities and NGOs and from the communities. The project is focused toward communities and the process explicitly involves and incorporates the people of the communities. Recognizing that communities are not homogenous, the project seeks dialog with a broad selection of groups. Since this program seeks to work with those people that are most in need, however, our principal beneficiary groups will be small-producers, land-poor families, women, and ethnic minorities.

Problem Model

The Problem Model is a process for describing, planning, implementing, and monitoring the integration of livestock into natural forest ecosystems to achieve sustainable production. The context chosen at the beginning was the interface between agricultural and forested ecosystems in mountainous regions that run throughout Latin America. This interface within nearly every country of Latin America was seen as the "internal frontier": a critical frontier between important watershed source areas and rapidly expanding clearing for logging and agriculture, a frontier as one of the last areas open for colonization by peoples forced to leave resource-poor regions, and a frontier of exploration of the unique rich biological diversity rapidly disappearing in the face of uncontrolled exploitation.

We wish to place our problem model focus into perspective with the following observations: The majority of livestock in these countries is NOT found in forested areas (although many are in formerly forested areas), and the majority of remaining forest area does not regularly harbor livestock. Nevertheless, at virtually EVERY forest:farm interface livestock are present and part of the problem and process of land degradation. Although livestock are not typically the reason for human colonization of these forested areas and may not constitute the main cause of deforestation and degradation of the watershed, livestock are important elements of the problem and the potential solution within these regions. Livestock are often directly associated with modification and/or clearing of natural vegetation as a result of grazing activities or needs. We believe, however, that appropriate management of carefully selected livestock can be ecologically sustainable and can improve the livelihood of the communities in these sensitive regions.

Frame of Reference and Target Sites

We refined our regional "frame of reference" to the following criteria: 1) regions in which livestock are an important element; 2) mountainous regions with an interface between natural forested ecosystems and agriculture; 3) regions with problems of deforestation, degradation of soils, and poverty; and

4) regions occupied primarily by small land holders.

In looking for suitable areas for target studies, it became clear from our in-country contacts and collaborators that there were many areas that fit these criteria and that the problems in these areas were legion, poorly studied, and rapidly increasing in magnitude. The problems include 1) deterioration of water sources for millions of people in the areas surrounding these mountainous forested ecosystems, 2) rapid loss of irreplaceable biological resources, and 3) degradation of the production potential of these regions, thereby reducing the carrying capacity of countries with an increasing problem of landless, resource poor peoples.

The value of these regions which our sites represent has been recognized as many fold: 1) they are very high in biodiversity with very high numbers of endemics (species with small geographic distributions unique to the regions), 2) their watersheds are critical sources of water for millions of people in surrounding areas, 3) they are sources of valuable non-timber forest products with a high potential for the discovery of new products, and 4) they are perceived as new sites for colonization by peoples leaving resource-poor areas. The residents and new colonists in these areas have hopes of finding a higher quality of life in these regions than appears available elsewhere. The challenge is to incorporate these people and their livestock into the regions in ways which can offer them a reasonable quality of life and which can sustain and be sustained by the natural ecosystems of these watersheds.

In choosing areas which were at the front edge of these "internal frontiers", we found that all of our areas were in the "buffer zones" of ecological reserves. In Mexico, our sites are in the official buffer zone of the Sierra de Manantlan Biosphere Reserve. In Ecuador, our sites are in the colonized corridor between three reserves: the Antisana and Cayambe-Coca Ecological Reserves and the Sumaco Napo-Galeras National Park. In Tarija, Bolivia, our sites are just north of the imperiled Tariquia Ecological Nature Reserve. All sites were chosen following the interests and advice of our in-country collaborators. The sites in Ecuador and Bolivia are in high priority environmental protection areas for the local USAID missions.

The Development Goal and Relevance

We recognized through information and direct site visits with our in-country collaborators that in most cases, the local colonists were employing methods of land use which contributed to the degradation of the regions in the "frontier" areas, and they were not taking advantage of the full range of options for resource use potentially available to them. To improve these situations, we began with the premise that the only way to attempt to achieve effective and lasting "sustainable" development within these areas was through local communities which had the ability, resources, and commitment to develop sustainable use of their land and its natural resources. We assume that the majority of the peoples in these landscapes intend to remain in the area, we assume that there in fact are few preferred or feasible options for relocation for many of them. For these rural peoples, we assume that livestock in one or more forms are essential for them to attain a reasonable quality of life.

The Approach to a Solution

Our emphasis in approaching the integration of livestock and the environment is to focus on a critical region (as defined above) and then deal how livestock can be incorporated into the environment in a manner which is ecologically sustainable and which can contribute to the improvement of the livelihood of local residents. We began with this premise, and our in-country collaborators have subsequently convinced us that this is the approach which is relevant to the needs of the local peoples and which has a chance to succeed.

Our approach has been developed and refined through the application of four "elements": 1) a wide variety of relevant disciplines have been included, 2) a wide range of different experiences have been included (NGO and University experiences, theory and practical application, research and action), 3) the entire effort has been oriented toward a common, agreed goal, 4) an integrating process was developed to incorporate and orient specific objectives and individual approaches towards our common goal. The process (Figure 1A, 1B, 1C) was developed to allow an adaptive approach to the planning of the work as well as the long-term planning of the community. As such, the "Integrated Process" has become both a guide and a goal of the proposed project. We refined our approach to the following main steps:

- To study the present and potential role of livestock in the livelihood of rural families and communities.
- To enhance local, community-based planning for the use and management of livestock and for the sustainable use of land and natural resources at the scale of the community's watershed.
- To work with rural families and communities in the development of sustainable, alternative uses of livestock and natural resources.

Work Areas of the Approach (Applying and Integrating Different Disciplinary Approaches)

To accomplish this approach we are integrating four areas of work which encompass different scales of focus and which incorporate different techniques and methodologies. The choices of areas and the definition, refinement, and integration of these areas have occurred throughout the assessment process and culminated in our Proposal Planning Workshop in Quito at the end of May.

The first work area deals with community organization and self-diagnostic participatory research and planning approaches with local communities. This aspect of work will be essential in determining the roles that livestock of various types play in the life of the local peoples and communities.

The second area of work focuses on livestock and land use. This work will focus on the relationship of livestock as a resource interacting with the vegetation types of the region, including croplands,

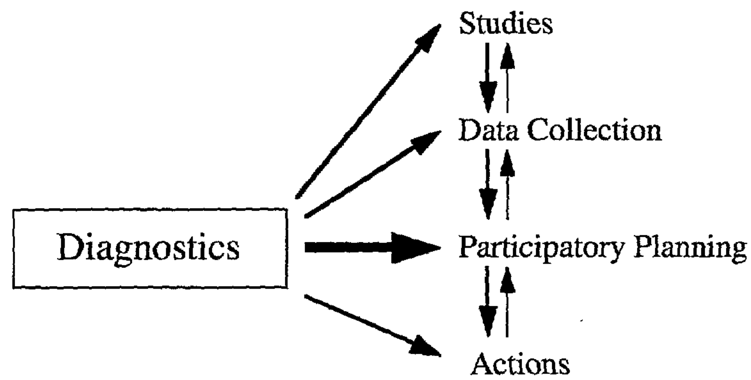

Figure 1A: Integrated Process of Research and Planning.

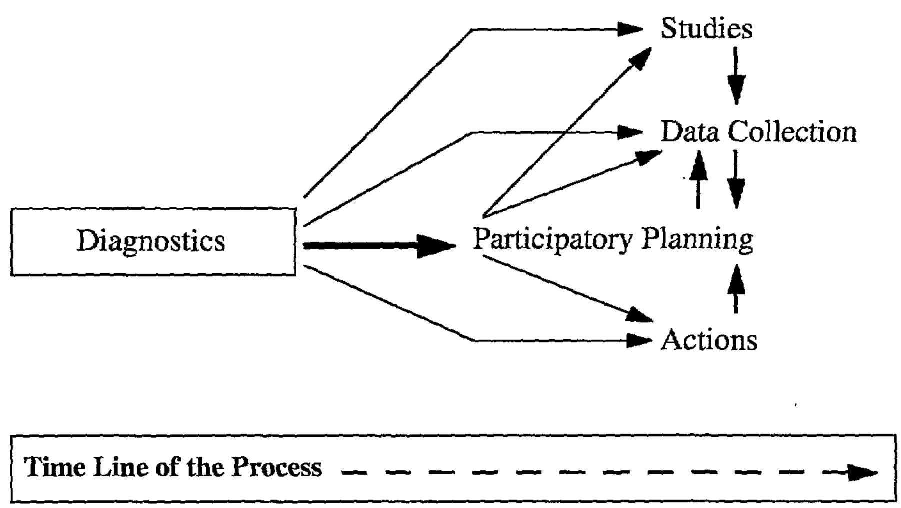

Figure 1B: Integrated Process of Research and Planning: Community input.

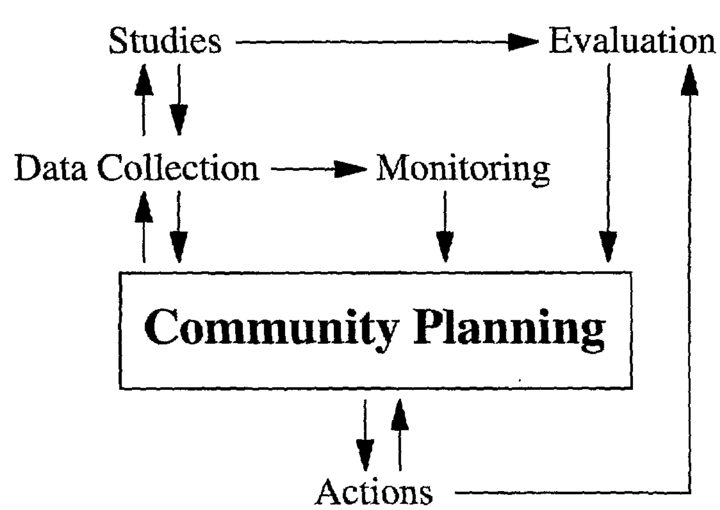

Figure 1C: Integrated Process for Community Planning.

pastures, and the various types of natural vegetation. This work will examine the interaction of different types of livestock on these land cover types. The consequences of these interactions will be analyzed 1) in terms of nutrition and production of livestock and 2) in terms of changes in the structure and composition of vegetation cover and changes in ecosystem services.

The third area of work will examine activities of the first two work areas at the scale of the landscape, and, in particular, the watershed. This area of work will employ mapping and remote sensing to examine changes in land use and ecosystem function at multiple scales. GIS will be employed to allow useful and effective integration of multiple scales of work and to facilitate spatial and temporal studies of changes in land use. This flexibility in scales of perspective will serve as the primary tool for tracking indicators of sustainability to assess the progress and success of changes resulting from the project.

The fourth area deals with environmental education and its effective incorporation in each of the work areas above in an attempt to enhance the information and planning base of the local people and communities. We believe that it is the education component which will serve to foster and facilitate the incorporation of the approaches of the project into the community.

The work areas were defined to direct attention to different types and scales of methods and perspectives which needed to be brought to bear on the common objectives of the problem model. Focusing attention on these work areas proved to be very effective in ensuring their incorporation in our specific objectives. It is very important to our approach to emphasize that the four areas of work have been tightly integrated. An examination of our specific objectives that all the objectives incorporate perspectives from more than one work area. (See objectives at end of report.)

Process of the Approach

Early on in the discussion and definition of the project goals with in-country collaborators, we developed an "Integrated Process of Research and Planning. This "process" is illustrated in Figure 1A. This diagram directly demonstrates the relationship of studies and data collection to community planning and actions. The diagram served to emphasize 1) the central importance of community planning as a goal of the project, 2) that all proposed studies will be designed to contribute directly to planning objectives, and 3) the necessity of feedback loops in order to have an adaptive planning process. Figure 1A proved useful as a starting point in the development of the project to guide the early stages of the project. This is illustrated in Figure 1B, in which the importance of early input by local communities in the planning of studies, data collection, and actions is emphasized. Figure 1C has been further elaborated to show later stages in the planning/research process and to illustrate the type of process envisioned as a final tool to be used by the community in their future planning.

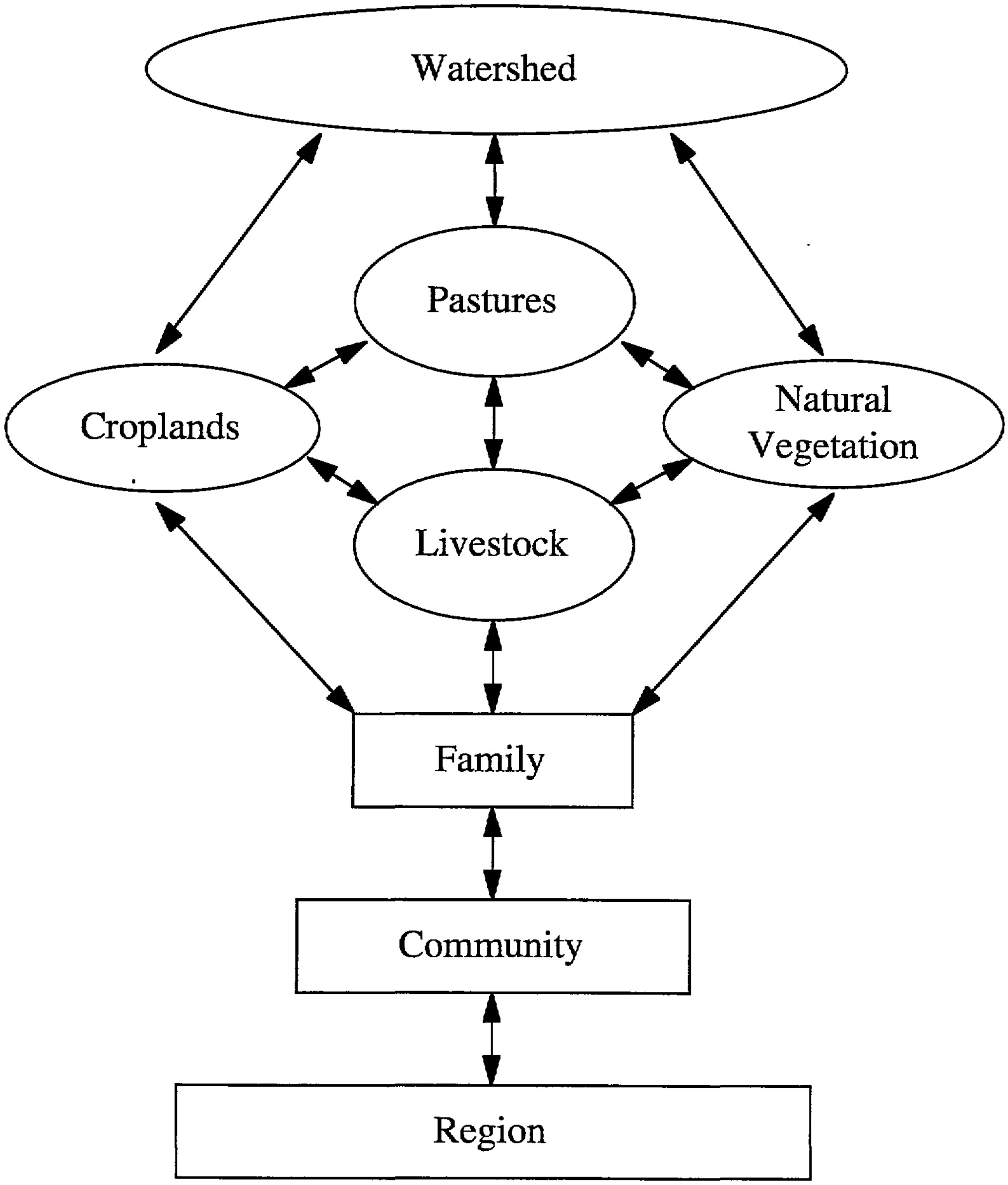

Figure 2: Units for indicators of sustainability and quality of life.

Monitoring and Evaluation

The final step in developing our approach deals with monitoring and evaluation (Figure 1C). The success of the project will be evaluated in part through the use of indicators of sustainability and quality of life. These indicators will be chosen to correspond to our objectives and to units representing different critical elements and scales of the problem model (Figure 2). For each unit (including different elements within the unit, for example, different types or breeds of livestock in the unit "Livestock"), we intend to employ indicators which satisfy criteria for useful indicators and which can be easily monitored and clearly interpreted by local farmers and other community members. The monitoring of such indicators is not only useful for the critical evaluation of the project's activities, but is an essential component of the long-term planning process of the community itself. The incorporation of monitoring and evaluation has thus become part of the approach to solving the problem model.

Constraints

The constraints to the solution of the problem defined by the Problem Model are challenging. The approach ultimately depends heavily on local community ability to plan and implement planning at the appropriate environmental scale. The long-term stability of the community is important to this process. This is a difficult prospect; nevertheless, we would argue that chances of success and implementation are still greatest at the local community level.

Second, the approach during the project depends on the effective collaboration among multiple parties, especially between local NGOs and local and U.S. university researchers. This depends on the nature of the interaction, resources available, and the stability of the NGO. We have deliberately chosen to work with NGOs with good track records and with strong potential for success.

Third, the local planning situation can change dramatically due to unforeseen circumstances and economic or policy changes outside the planning area. Such changes are inevitable. Our approach to face these outside influences is two-fold. One is to focus on the *process and basis* for planning and to foster an adaptive planning process within the local community. The second is to reinforce relationships with outside support groups, especially with partner NGO's committed to a long-term relationship with the community and with official liaison status with government agencies. Such relationships are present at all three of our selected study site areas.

Assessment Team Process and Progress

Overview of Proposed Assessment Team Activities

Our goal for the 9-month assessment team process was three-fold: 1) development of the problem model including selection of countries and study sites, 2) building of a multi-national interdisciplinary team, and 3) collaborative development of a full proposal to address solutions to the problem model. We planned work in four stages.

First, we gathered our local team multiple times to define the general goals and general intent of our approach. Our local University of Wisconsin (UW) team represented a number of disciplines and a wide variety of experience in Latin America. We used our experience and contacts to seek advice, partners, and study sites in each target country. Mexico was selected from the beginning because of the prior independent development of a very similar problem model and approach with the researchers at IMECBIO (Instituto Manantlán de Ecologia y Conservación de la Biodiversidad), of the University of Guadalajara. Ecuador was selected due to the extensive experience of the group in Ecuador and the known existence of many suitable sites. Bolivia was selected for the same reasons and for the opportunity for strong community-based local development encouraged by the recent passage of the Popular Participation law in Bolivia.

Second, to identify suitable partners and study sites in Ecuador and Bolivia, we visited representatives from 33 different organizations in the two countries meeting more than 80 people in 44 different meetings. The advice and perspective we gained from these meetings were invaluable. In both countries, we found and engaged interested, capable partners to collaborate in the development of the project. We visited various field sites in both countries and were able to choose suitable sites in both countries. These visits in person by several members of the initial assessment team were absolutely essential for our understanding of the local situation and for building an effective team with host country partners. The two visits with the new groups and to the new sites in Ecuador and Bolivia proved to be a very useful minimum (the researchers at IMECBIO in Mexico had been visited at some length on several occasions before the start of the planning year). Within these visits, two formats were both invaluable: 1) visits in the field with local researchers including meeting local people in the communities, and 2) frank discussions of goals and objectives with several collaborators representing different organizations and different disciplines. Open sharing of information was employed in all these meetings and proved very effective in building trust and an open exchange of ideas.

Third, we arranged for a Proposal Planning Workshop to be held in Quito, hosted by our newly found Ecuador partners. Twenty-six people participated in this workshop representing our partner organizations in all three countries as well as members of the original local UW team. The workshop was intended to provide 1) a meeting place for all the partners to become acquainted with each other and with the sites in each country (through presentations and information exchange), and 2) an opportunity for all the team members to participate directly in the design of the project proposal. The meeting was run to encourage input from all the participants. Breaking frequently into small thematic groups with representation from each country was particularly effective and led to more general and open discussion in following plenary sessions. This meeting was very useful and very successful in binding the different country teams together, and it was very successful in developing and refining the specific objectives. The format also allowed a frank discussion of the limitations of the in-country groups in such a way as to refine the scope and timing of objectives to achieve a more feasible work plan for the proposed project.

The importance of these planning activities cannot be underestimated. Regardless of future success in obtaining funding, representatives of the host country working groups have had a taste of cooperating with each other and a gain in perspectives for other groups from other regions. This was most notable in the surprise many showed when presented with the similarity in the problems faced in sites which are quite separate in physical distance. Thus the planning process itself has played a role in facilitating and strengthening the abilities of all the collaborators. In addition, we are now connected via email to continue contact and exchanges of ideas and experiences.

The fourth stage involves the final collating of information and writing of the proposal. This is being carried out in Wisconsin with a regular flow of information from the collaborators in each country. Several of the team members in Wisconsin will contribute substantially to this final stage. It would have been good to have had funds to bring a few key collaborators to Wisconsin to participate more directly in this last phase; nevertheless, the ease of email and the firmer personal knowledge and understanding established among the team members will facilitate exchange during this period. We are looking forward to working with our new colleagues in the future and have built annual multi-country workshops into the work plan.

Progress

Interdisciplinary Approach

We have experts from very diverse backgrounds: animal science, economics, GIS, botany, ornithology, sociology, land tenure, monitoring. Descriptions of our approach to the Problem Model and the format and results of our Proposal Planning demonstrate a very strong and well integrated interdisciplinary approach.

The entire approach has been developed around a common set of overall goals with work areas and levels integrated to arrive at participatory community planning (Figure 1A, 1B, 1C). We have developed a project "vision" statement to guide all aspects of the workplan. This was developed in concert with advice from several team members and has since served well to keep us all moving toward the same goal.

Composition of the Assessment Team

We have carefully selected and worked with our partners to obtain a strong, capable team in each country. We have pared down our sites to three to allow more time and resources for those three groups. The process of using four thematic work areas, especially during the Proposal Planning Workshop, has clarified the needed roles to be filled and has identified needs. All of us now have a much clearer idea of what we need to do and who is capable of doing it. The additional U.S. collaborators we have added have been chosen precisely because of special expertise and interest in specific target objectives.

Composition of the in-country groups of associates followed a strategic plan to build a local team capable of filling certain key local project needs. We chose groups with the following characteristics: 1) work record in the area of expertise, 2) commitment to local rural community development, 3) compatibility within the groups of associates, 4) experience appropriate to the study area, 5) capability to carry out the proposed work, 6) strong interest in the general problem model of the proposed project. Two particular areas were considered critical: 1) participatory community organization and planning, 2) cartography and GIS. These areas have been now covered by excellent groups in each site.

Each project partner will have a well-defined role so that each role in the project is fulfilled (i.e., in the case of Ecuador, FUNAN will do community autodiagnostics, natural resource management; HPI will do livestock management, CDC will do monitoring, mapping; Terranueva will do socioeconomic investigation, natural resource management, community autodiagnostics, etc.). Having defined their principal roles, each participant will cooperate with others to fit their work into an integrated framework. The work plans which have now been developed demonstrate integration of skills in a cooperative, complementary fashion.

Policy Relevance

In all three sites, we have partners who have official links with government agencies concerned with management of the natural parks and with management and policy related to the peoples and human extraction/production activities in the buffer zones of the ecological reserves. In Mexico, IMECBIO has a very close working relationship with SEMARNAP, the agency charged with management of the Sierra de Manantlan Biosphere. In Ecuador, FUNAN has an official link with INEFAN in the management of the Antisana Ecological Reserve and its buffer areas. In Bolivia, PROMETA has an official link with the Government for the management of Tariquia National Flora and Fauna Reserve.

Demand Driven

Our in-country partners will build on their established relationships with local communities to incorporate local residents, farmers and local leaders in a community participatory approach to problem-solving. We have also now had opportunities to visit a number of local communities and meet local families and livestock owners. We are adapting our process and timelines to facilitate this approach. In particular, the community and education work areas are incorporating specific gender emphases. This is particularly necessary given the importance of the household unit as the production unit among small land holders in these regions.

Consortia Approach

We have developed potentially strong working relationships within in-country groups of partners and have initiated the basis for a broader exchange among the four countries. We have also now linked with interested researchers from four other U.S. research institutions who have specialized expertise to be applied to specific objectives of the project.

Impacts and Benefits

- Implementation of more sustainable production systems locally. Sustainable use of these fragile ecosystems portends major benefits to areas surrounding the watershed in terms of continued availability of clean water and reduced risk of flooding.
- Better management of the forested ecosystems increases the potential for future benefits derived from the rich biological resources, such as non-timber forest products (medicines and foods) and ecotourism.
- Development of a planning *process*

that will have immediate local impact and regional impact as a general problem-solving process.

- Training of A.I./embryo implant technicians, training for environmental monitoring, training of local degree and non-degree students.
- Development of integrative indicators for sustainability.

Mode of Operation

Team-building capability demonstrated by many team projects that LNRI participants have been involved in. Ex: Land Tenure Centre team work, Tim Moermond's team work in China, The Sierra de Manatlan project (T Moermond and T Yuill), HPI links with all their partners, etc....

Integration of Other Funding Sources

We have been and will continue to actively seek funds from a variety of sources:

- We have secured a substantial buy-in to the project through the University of Wisconsin-Madison: three fully funded graduate assistantships plus an additional $5000 for travel per year (these funds are in additional to the matching funds). We are seeking further university funds through the Institute for Environmental Studies.
- IMECBIO has secured funds from ODA which apply to a diagnostic study of the impact of cattle grazing over the entire reserve.
- We will apply to the Bi-National and Tri-National Commissions of Bolivia which are concerned with environmental management of two international watersheds, those of the Rio Bermejo and Rio Pilcomayo respectively.
- We will apply for funds from the Ecuadorian cattle raisers associations for technology development.
- We will apply for funds from municipalities in the area of our Bolivian sites. The municipalities now have funds ear-marked for environmental projects.
- We will apply for research grants from NSF, The Nature Conservancy, and the National Geographic Society (Natural Habitats Program).

Future Activities

Plans if Funded

The full set of activities encompassing approaches from each of the work will be carried out by participating team members and institutions in each of the country study sites. Responsibility for carrying out each objective for local and U.S. collaborators will be planned on a feasible timeline for a six year period.

The first stage will consist primarily of developing community participation and beginning autodiagnostics followed by other inventory and assessment work. This will be followed by participatory studies of livestock and vegetation interaction (including cropland and pastures) and by mapping and GIS work. Education components will be incorporated at different levels over the period of the project in accordance with community needs and goals.

The principal goal is the improvement of the livelihood of rural peoples and of the quality of their environment through sustainable systems of land use and livestock management in the regional situation defined in the problem model. The following steps discussed under the problem model serve to move from the main goal to tangible objectives.

- To study the present and potential role of livestock in the livelihood of rural families and communities.
- To enhance local, community-based planning for the use and management of livestock and for the sustainable use of land and natural resources at the scale of the community's watershed.
- To work with rural families and communities in the development of sustainable, alternative uses of livestock and natural resources.

The series of specific objectives listed below provide more detailed picture of the type and nature of the approach and work plan developed for the proposal. It will be seen that the objectives vary in their breadth and specificity. The final proposal will show how they relate to each other and will elaborate the specific actions to be applied to carry out these objectives. Team members and timelines will be assigned to each objective to allow more effective planning for implementation. Each objective will be elaborated in terms of measurable products, impacts, beneficiaries, and relevance. Two examples so elaborated are provided in an Objective Matrix at the end of this report.

Specific Objectives

- To promote the implementation of sustainable alternatives for the management of natural resources, with emphasis on livestock. These alternatives will be generated in a participatory manner.
- To characterize livestock as a resource which has impacts of varying degrees and manners on vegetation, as a function of its grazing activities.
- To explore and understand the potential and limitations of livestock management in the site area, including land use, livestock species, and technologies.
- To improve the nutrition of livestock by studying local forage species, comparing local species to other available species, and by evaluating the health and nutritional needs of the local livestock.
- To improve the genetic stock of local livestock by experimenting with cross-breeding between highly productive temperate species and locally adapted species.
- To study the benefits of different feeding strategies by comparing the overall impacts of grazing (on both vegetation and livestock) versus feeding livestock in confinement. Gender division of labor will be of particular concern here.
- To generate a participatory process for monitoring the effects of both traditional practices and the alternative strategies adopted for the management of natural resources.
- To create a database of information generated by the working groups and available from secondary sources to characterize the watershed in a GIS.
- To use GIS tools to evaluate current and potential land uses, in order to plan for the future.
- To analyze the interactions between people, agriculture, livestock and natural ecosystems at levels ranging from the household up to the

watershed. Gender issues will be a special focus of this objective.

- To develop a database of indicators of sustainability generated by the work groups, which can be evaluated and monitored over time.
- To determine indicators of health for local ecosystems, so as to monitor changes in their status over time.
- To determine the resource values of components of local forested ecosystems, so as to assess their actual and potential use in the community.
- To identify the potential and limitations within the community for achieving sustainable management of its resources and improving the quality of life.
- To incorporate the participation and support of local governing bodies and leaders with respect to policies and practices governing the management of natural resources.
- To build the local community members' understanding of and capabilities for managing the interactions among agro-pastoral practices and natural ecosystems. This area also depends on attention of gender division of labor.
- To build a program with campesino families to improve their nutrition and health. Particular attention here will be focused on mothers and children.
- To develop a program of formal environmental education with local schools.

Training

Training will occur in multiple levels and will be linked with the overall education strategy.

Host Country University Students

At each site, 10% of the budget will be used for grants to facilitate participation of students from universities within the country. Students will be supported to complete thesis work on well-focused studies designed to contribute directly to project objectives. Contacts have been made at appropriate universities in each country (Figure 3). Additional students working through IMECBIO in Mexico will be supported through other funding sources. We expect a minimum of six students supported per year. It is hoped that excellent students at this level will be identified as candidates for continuing at the UW in subsequent years of the project.

U.S. University Students

A minimum of five graduate students and one postdoctoral student from the University of Wisconsin-Madison are expected to participate in this project each year. Three student research assistantships will be provided by the UW as direct investment in this project. One additional student will be supported by a combination of a UW Fellowship and an NSF Fellowship. A project assistantship and the postdoctoral student are intended to be supported through the CRSP grant funds.

Research Workshops/Exchanges

Workshops at each site and annual multi-country workshops are planned to enhance the exchange of ideas, experiences, and findings among researchers.

Objective 1: To promote the implementation of sustainable alternatives for the management of natural resources, with emphasis on livestock. These alternatives will be generated in a participatory manner.

Products	**Impacts**	**Actions**	**Beneficiaries**	**Time/Personnel**	**Relevance**
1. The identification and selection of alternative resource management strategies. 2. Evaluation of the viability of selected alternatives. 3. Diffusion and eventual adoption of the alternatives.	1. A major contribution to family well-being. 2. More sustainable interactions between livestock and natural resources.	1. Workshops and field visits. 2. Technical assistance. 3. Design, experimentation, and evaluation of technological alternatives and organizational strategies.	Small landholders and other members of the community. People depending on the services of the watershed.	Throughout the project. UW-Madison, IMECBIO, PROMETA, CER-DET, Terranueva, HPI, FUNAN.	Sustainable management of the resources is essential to the integrity of the watershed and maintenance of community members' livelihoods over time.

Objective 2: To develop mixed breeds of dairy cows adapted to the climatic conditions of the tropics.

Products	**Impacts**	**Actions**	**Beneficiaries**	**Time/Personnel**	**Relevance**
To increase the efficiency of milk production using tropically adapted breeds and species. We will emphasize bantang (Bos javanicus), as it is a browser.	Greater milk production with fewer cows, and hence less environmental damage.	Perform embryo transfer with highly heterotic crosses (between species) and evaluate their suitability for tropical milk production.	Small landholders.	Throughout the project. UW-Madison (J. Rutledge and student), HPI (Hector Ballesteros), local veterinarians in each site.	100 years of breeding programs have failed to produce a superior tropical dairy cow. Our plan will produce this for small landholders.

Local Training Workshops

Workshops will also be planned for local farmers and other focus resident groups for education purposes (these will be part of an overall environmental education strategy to be coordinated by CIEC in Bolivia in cooperation with collaborators at each site.

ASSESSMENT TEAM MEMBERS

A table of team members is attached. This table includes all those who are currently scheduled to work on the proposed project in the future. The list of collaborators is long, but in reality very well organized. Each country has a designated coordinator to facilitate and

Figure 3: Livestock-Natural Resources Interfaces Project. Coordinator: Timothy Moermond, UW-Madison

THREE SITES: LOCATION, COORDINATOR, COLLABORATING ORGANIZATIONS

MEXICO

1) JALISCO

RIO AYUQUILA WATERSHED, **ZENZONTLA** AREA
BUFFER ZONE OF *SIERRA DE MANANTLAN BIOSPHERE RESERVE*

COORDINATOR: **Dominique Louette, IMECBIO**
COLLABORATING ORGANIZATIONS: **IMECBIO, SEMARNAP**
EXPECTED COLLABORATION/TRAINING: Univ. of Guadalajara

ECUADOR

2) NAPO

RIO QUIJOS WATERSHED, **BAESA** AREA (communities Cuyuja and Cosanga)
"BUFFER ZONE" BETWEEN *ANTISANA ECOLOGICAL RESERVE, CAYAMBE-COCA NATURE RESERVE, and SUMACO NAPO-GALERAS NATIONAL PARK*

COORDINATOR: **Hector Ballesteros, HPI**
COLLABORATING ORGANIZATIONS: **FUNAN, HPI, TE, CDC**
EXPECTED COLLABORATION/TRAINING: Univ. Central of Ecuador, Escuela Superior Politécnica de Chimborazo, Univ. Católica

BOLIVIA

3) TARIJA

RIO BERMEJO AND RIO PILCOMAYO WATERSHEDS, **ENTRE RIOS** AREA (communities LA CUEVA and TIMBOY)
"BUFFER ZONE" AT EDGE OF *TARIQUIA NATIONAL FLORA AND FAUNA RESERVE (identified in Parks in Peril program)*

COORDINATOR: **Javier Cabero, SEAD**
COLLABORATING ORGANIZATIONS: **SEAD, PROMETA, CER-DET, ZONISIG, CIEC**
EXPECTED COLLABORATION/TRAINING: Univ. Autonoma Juan Misael Saracho

coordinate the activities of member institutions. Each of these institutions has its own internal organization and mechanisms to apply people to objectives (the expected time commitment to the future project varies from 10% to 50%). A "T" in the first column of the table denotes those individuals who have contributed significantly to the design of the project proposal. Nearly all of these participated in the Proposal Planning Workshop; however, some have contributed in other ways also.

The entire list includes 68 proposed collaborators: 12 from Mexico, 19 from Ecuador, 21 from Bolivia, and 16 from the United States (12 of those are from the UW, 4 are from 4 other institutions: the University of California—Davis, Colorado State University, the University of Minnesota—Duluth, and the Laboratory of Ornithology at Cornell. Each persons expertise and expected contribution to the proposed project is noted.

Workshops

A Proposal Planning Workshop was held in Quito for three days full days (May 28-30). The workshop included key representatives from all the collaborating institutions in Mexico, Ecuador, Bolivia, and the U.S. Twenty-six persons participated in the workshop (7 from the U.S., 8 from Ecuador, 7 from Bolivia, and 4 from Mexico)

The purpose of the workshop was six-fold:

- To allow team members from all the countries to become acquainted with each other and with the characteristics of the study sites in each country.
- To decide on main goals and to develop specific objectives appropriate and practical to accomplish these goals.
- To design common approaches with common methodologies appropriate for meeting the objectives.
- To integrate work plans and define specific roles for each participant and group for each site that were feasible given the limitations of people and resources over the proposed six year periods of the project.
- To discuss and coordinate the collection and development of materials for the final proposal.
- To agree upon future modes of operation To facilitate communication and open, effective exchange of ideas among all team members and institutions.

The workshop was successful beyond our expectations. The introductory section in which the country sites were described emphasized to everyone the commonality of the situations and of the general applicability of the Problem Model. This provoked an immediate exchange among participants from the different regions. In the mixed sessions that followed EVERYONE participated and contributed substantive ideas. Most of the work was done in thematic groups centered around the four work. The work of these groups was discussed within each study site group and in plenary session of all participants. The Problem Model which had been developed slowly over the previous six months was confirmed, elaborated, and refined into specific, feasible, objectives which were developed jointly by the entire group of team members.

Collaborating Institutions

United States

University of Wisconsin - Madison
International Agricultural Programs
240 Agricultural Hall,
1450 Linden Dr.
Madison, WI 53706
Tel: 608-262-1271
Fax: 608-262-8852

Bolivia

Centro de Estudios Regionales para el
Desarrollo de Tarija, CER-DET
Casilla 83
Tarija, Bolivia
Tel: 591-66-35471
Fax: 591-66-33454

Centro Interdisciplinario de Estudios
Comunitarios, CIEC
C. Belisario Salinas No. 228
Casilla 159
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Fax: 591-2-432-662

Proteccion del Medio Ambiente Tarija,
PROMETA
Mendez 172, Casilla 59
Tarija, Bolivia
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Fax: 591-66-33873

Servicios de Apoyo al Desarrollo, SEAD
Melchor Pérez de Holguin 2408
La Paz, Bolivia
Telefax: 591-2-410-420

Proyecto Zonificacion Agro-ecologica y
Establecimiento de una Base de Datos y
Red de Sistema de Informacion
Geographica en Bolivia, ZONISIG
Casilla 502
Tarija, Bolivia
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Fax: 591-66-45659

Ecuador

Centro de Datos para la Conservacion,
CDC
Alfonso de Lamartine #175
Casilla 17-21-332
Quito, Ecuador
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Fax: 593-2-245-189

Fundacion Antisana, FUNAN
Av. Mariana de Jesus s/n y
Martin de Utreras
Casilla 17-03-1486
Quito, Ecuador
Telefax: 593-2-433-851

Heifer Project International, HPI
San Ignacio 134 y 6 de Diciembre #8
Quito, Ecuador
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Terranueva, TE
Calle Mallorca 440 y Coruna
Casilla 17-12-144
Quito, Ecuador
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Fax: 593-2-507-865

Mexico

Instituto Manantlán de Ecologica y
Conservación de la Biodiversidad
Universidad de Guadalajara, IMECBIO
Ave. Independencia Nacional #151
Autlan de Navarro,
Jalisco, Mexico 48900
Tel: 52-338-11165, 10353
Fax 52-338-11425

Team Member Name	Affiliation	Role/Discipline	Nationality/Residence
I. Ecuadorian Team Members			
Almeida, Pablo	Centro de Datos para la Conservacion (CDC), Quito, Ecuador	Geographer/GIS specialist. Cartography, GIS.	Ecuadorian/Ecuador
Arroyo, Paulina	Fundacion Antisana (FUNAN), Quito, Ecuador	Planner/coordinator of social research, and community involvement	Ecuadorian/Ecuador
Baez, Sara	Terranueva	Anthropologist, Lawyer	Eduadorian/Ecuador
Ballesteros, Hector	Heifer Project International (HPI), Quito, Ecuador	Coordinator	Ecuadorian/Ecuador
Calispa, Fabian	Terranueva	Agroecologist	Ecuadorian/Ecuador
Campos, Felipe	CDC	Zoologist, Taxonomist	Ecuadorian/Ecuador
Castillo, Marco	Terranueva	Agronomist	Ecuadorian/Ecuador
Castillo, Mauricio	FUNAN	Agronomist	Ecuadorian/Ecuador
Chancay, Sandra	HPI	Community Activity Assistant	Ecuadorian/Ecuador
Chancusig, Edwin	HPI	Agroecologist/Technical Assistant	Ecuadorian/Ecuador
Guerrero, Fernando	HPI	Sociologist	Ecuadorian/Ecuador
Guevara, Marcelo	CDC	Geographer	Ecuadorian/Ecuador
Jervis, Maria Helena	FUNAN	Executive Director	Ecuadorian/Ecuador
Josse, Carmen	CDC	Plant ecology	Ecuadorian/Ecuador
Larrea, Fernanrdo	HPI	Anthropologist	Ecuadorian/Ecuador
Mosquera, Gustavo	FUNAN	Technical Director, Biologist	Ecuadorian/Ecuador
Murillo, Isabel	FUNAN	Technical Assistant	Ecuadorian/Ecuador
Ordonez, Martha	Terranueva	Sociologist	Ecuadorian/Ecuador
Penafiel, Marcia	CDC	Botanist	Ecuadorian/Ecuador

Team Member Name	Affiliation	Role/Discipline	Nationality/Residence
II. Bolivian team members			
Baldivieso, Javier	Proteccion del Medio Ambiente Tarija (PROMETA), Tarija, Bolivia	Forester	Bolivian/Bolivia
Baracatt, Gabriel	Proteccion del Medio Ambiente Tarija (PROMETA), Tarija, Bolivia	Lawyer	Bolivian/Bolivia
Beek, Martin MSc	Centro de Levantamientos Aeroespaciales y Aplicaciones SIG para el Desarrollo Sostenible de los Recursos Naturales (CLAS), Universidad Mayor San Simon (UMSS), Cochabamba, Bolivia	GIS Specialist	Dutch/Bolivia
Cabero, Javier	Servicios de Apoyo al Desarrollo (SEAD), La Paz, Bolivia	Psychologist	Bolivian/Bolivia
Castellanos, Jorge	Servicios de Apoyo al Desarrollo (SEAD)	Business Administration	Bolivian/Bolivia
Castro, Miguel	Centro de Estudios Regionales para el Desarrollo de Tarija (CER-DET), Tarija, Bolivia	Lawyer	Bolivian/Bolivia
Chavez, Freddy	Proteccion del Medio Ambiente Tarija (PROMETA), Tarija, Bolivia	Social Psychologist	Bolivian/Bolivia
Erazo, Orlando	Centro de Estudios Regionales para el Desarrollo de Tarija CER-DET, Tarija, Bolivia	Forester	Bolivian/Bolivia
Espinoza, Linder	Proyecto Zonificacion Agro-ecologica y Establecimiento de una Base de Datos y Red de Sistema de Informacion Geographica en Bolivia(ZONISIG), Tarija, Bolivia	Forester	Bolivian/Bolivia
Jung, Jorge Eduardo	Centro Interdisciplinario de Estudios Comunitarios (CIEC), La Paz, Bolivia	Environmental Education	Bolivian/Bolivia

Team Member Name	Affiliation	Role/Discipline	Nationality/Residence
II. Bolivian team members, continued			
Montano, Blanca	Centro de Estudios Regionales para el Desarrollo de Tarija (CER-DET), Tarija, Bolivia	Psychologist	Bolivian/Bolivia
Penaloza, Eliana	Centro de Estudios Regionales para el Desarollo de Tarija (CER-DET), Tarija, Bolivia	Administrator	Bolivian/Bolivia
Roth, Erick	Centro Interdisciplinario de Estudios Comunitarios (CIEC), La Paz, Bolivia	Environmental Education	Bolivian/Bolivia
Ruiz, Jorge Regional Coordinator- Tarija	Proyecto Zonificacion Agro-ecologia y Establecimiento de una Base de Datos y Red de Sistema de Informacion Geographica en Bolivia (ZONISIG), Tarija, Bolivia	Administrator, GIS Specialist	Bolivian/Bolivia
Telleria, Waldo	SAI	Agronomist/Geneticist	Bolivian/Bolivia
Thomson, Sandra Ecologist	Centro de Estudios Regionales para el Desarrollo de Tarija (CER-DET), Tarija, Bolivia	Ecologist. Environmental education	Canadian/Bolivia
Turner, Andrew, Anthropologist	CER-DET, Tarija, Bolivia	Anthropologist	American/Bolivia
Vacaflores, Carlos Agronomist	Proteccion del Medio Ambiente Tarija (PROMETA), Tarija, Bolivia	Agronomist, Research Coordinator -Tarija	Bolivian/Bolivia
Valdez, Alipio	CER-DET	Facilitator	Bolivian/Bolivia
Valenzuela, Carlos Ph.D.	Centro de Levantamientos Aeroespaciales y Aplicaciones SIG para el Desarrollo Sostenible de los Recursos Naturales (CLAS), Universidad Mayor San Simon, Cochabamba, Bolivia	GIS Specialist	Bolivian/Bolivia
Vedia, Javier	PROMETA	Agronomist	Bolivian/Bolivia

Team Member Name	Affiliation	Role/Discipline	Nationality/Residence
III. Mexican team members - (University of Guadalajara – IMECBIO)			
Aguilar, Cesar	IMECBIO, Universidad de Guadalajara	Veterinarian	Mexican
Carranza, Arturo	IMECBIO, Universidad de Guadalajara	Agronomist	Mexican
Carranza, Mario	IMECBIO, Universidad de Guadalajara	Agronomist	Mexican
Cuevas, Ramon	IMECBIO, Universidad de Guadalajara	Botanist	Mexican
Dario, Ruben	IMECBIO, Universidad de Guadalajara	Soil Scientist	Mexican
Garcia, Salvador	IMECBIO, Universidad de Guadalajara	Biologist	Mexican
Iniguez, Luis	IMECBIO, Universidad de Guadalajara	Zoologist	Mexican
Jardel, Enrique	IMECBIO, Universidad de Guadalajara	Ecologist	Mexican
Louette, Dominique	IMECBIO, Universidad de Guadalajara	Agronomist	French
Martinez, Luis Manuel	IMECBIO, Universidad de Guadalajara	Soil scientist	Mexican
Pineda, Maria del Rosario	IMECBIO, Universidad de Guadalajara	Ecologist	Mexican
Sanchez, Lazaro	IMECBIO, Universidad de Guadalajara	Botanist. Co-coordinator.	Mexican

Team Member Name	Affiliation	Role/Discipline	Nationality/Residence
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Menke, John	University of California-Davis Department of Agronomy and Range Science Davis, CA	Range ecologist	American
Moermond, Timothy	University of Wisconsin-Madison Professor, Department of Zoology Chair, Conservation Biology Sustainable Development Program	Principal Investigator, Zoologist	American
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Pastor, John	University of Minnesota-Duluth Professor of Biology Resources Research Institute, Duluth, MN	Range ecologist	American
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Rutledge, Jack	University of Wisconsin-Madison Department of Animal Science Madison, WI	Animal Scientist	American

Assessment of the Importance of Animal Products for the Nutrition of Young Children in the Andean Region: Team Building and Identification of Appropriate Animal Products

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Narrative Summary

Malnutrition of young children is extremely common in the rural highlands of Andean countries, in part because of the poor quality of children's diets. Recent evidence from the global scientific literature suggests that this high rate of childhood malnutrition can be ameliorated by increased consumption of animal products. During the past seven months a consortium of U.S. universities, Peruvian universities and research institutions, international agricultural research centers, and national and regional non-governmental organizations was therefore established to plan and conduct future research and community-based programmatic interventions to enhance the production and improve the processing of animal products and to promote increased consumption of these products by young, Andean children.

Preliminary qualitative and quantitative research was conducted by an interdisciplinary team composed of animal and range scientists, food scientists, social scientists, and human nutritionists. The results of this research indicate that severely limited household economic resources currently obligate poor families to sell their animal production to obtain other household necessities rather than consume the animal products directly. Thus, to promote increased consumption of animal products, it seems that an integrated approach will be necessary to increase the efficiency of animal production simultaneously with any proposed changes in consumption behavior. These preliminary studies further suggest that, among the locally available animal products, milk is the food item that is currently consumed in greatest quantity and is perceived as most suitable for young children.

Future research activities will be carried out in four general areas: socio-economic and ethnographic research, animal nutrition and animal health, food science, and human nutrition. A household survey will be completed to assess the relationships between different systems of household and community animal production and the consumption of animal products. At the same time community organizations will be analyzed to identify those that are most interested in and capable of delivering these food products to the target group. This information will be used to plan the most effective intervention designs. To

increase the efficiency of animal production, a field research station will be established on land ceded by rural communities. Simple methods will be developed to improve range management, enhance animal nutrition, and identify and control common animal diseases. In the area of food science the composition and microbiological safety of milk will be studied prior to developing appropriate ways of processing milk to provide safe and nutritious milk-derived products for young children. Finally, the impact of greater milk consumption on children's growth, micronutrient status, general health, and behavioral development will be assessed. The results of these studies and programmatic interventions will be disseminated through a regional network of development organizations.

Problem Model

Our original problem model focused almost exclusively on the relationship between the consumption of animal products and children's nutrition and function. However, as described below, the results of our preliminary qualitative research suggested that, despite the likely nutritional benefit of animal products, the relatively high cost of these products coupled with poor household economic status are critical constraints to increased consumption. Most families reported selling the bulk of their production to allow them to purchase other household necessities. Thus, it seems that it will be possible to promote increased consumption of animal products only if the total amount or efficiency of production is increased, household income is augmented, and/or social welfare programs are implemented to distribute these products, subsidize their cost, or influence decision-making concerning the acquisition and intra-family distribution of foods. Therefore, we are now convinced of the necessity of developing integrated programs that will attempt to increase the efficiency of animal production and enhance local food processing capacity, while simultaneously encouraging greater consumption by young children. The revised problem model, which is illustrated in the accompanying figures,

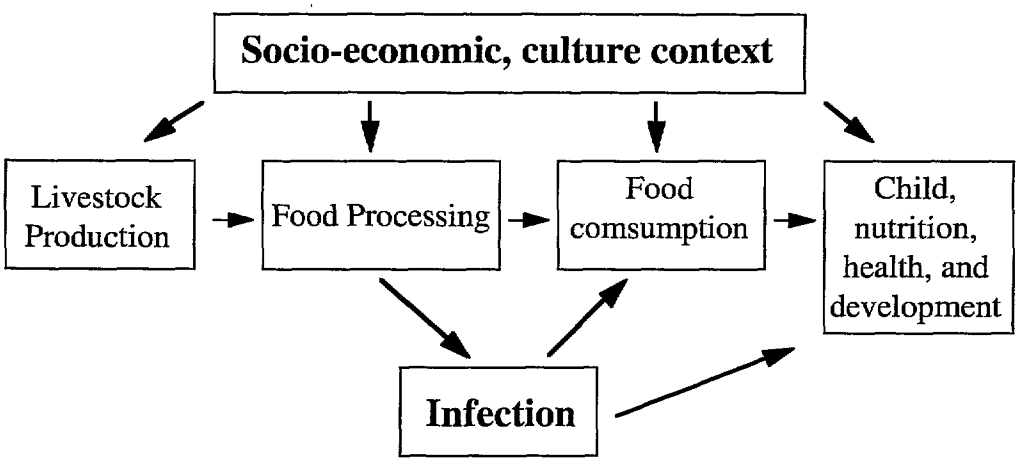


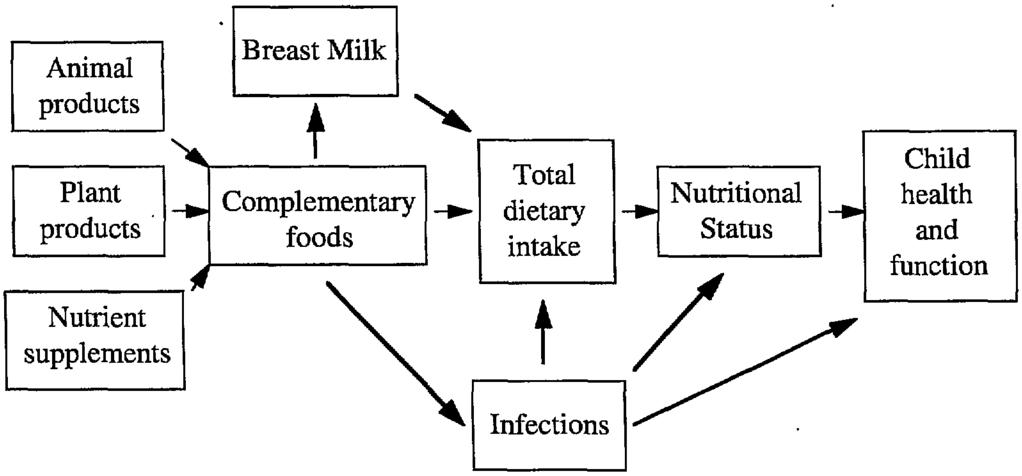
Figure 1: Problem Model 1 - Enhanced livestock management and processing of animal products to improve the nutrition, health, and development of young Andean children.

encompasses each of these related sets of issues.

Another concern of the assessment team was the identification of appropriate animal products for consumption by young children. Several types of information were reviewed in relation to the availability and consumption of different products and the attitudes governing their use for child feeding. As indicated in the results below, milk is the animal product that is deemed most appropriate for young children and is consumed in greatest amounts. Other products were either less available or perceived to be less suitable for young children. Thus, we have decided to give primary emphasis to production and processing of dairy foods in our future activities.

Another component of the revised problem model concerns food safety. We learned from our field visits that dairy production is limited by lack of market access and adequate techniques to preserve milk. Most milk is not pasteurized and there is little knowledge of processing techniques other than production of butter and fresh cheese. Information is needed on the composition and microbiological quality of milk to develop appropriate foods that can be prepared safely by small-scale dairy operations. Likewise, animal diseases that affect the safety of milk and the health of field personnel must be identified and controlled.

Figure 2: Problem Model 2.



Assessment Team Process and Progress

Overview

The major activities that were planned during the assessment team phase were to : 1) establish an interdisciplinary team to plan future research and interventions to increase consumption of animal products by young Andean children, 2) convene two workshops to develop the problem model and prioritize these future research activities, 3) carry out preliminary qualitative research and analysis of existing dietary data to determine the appropriate animal

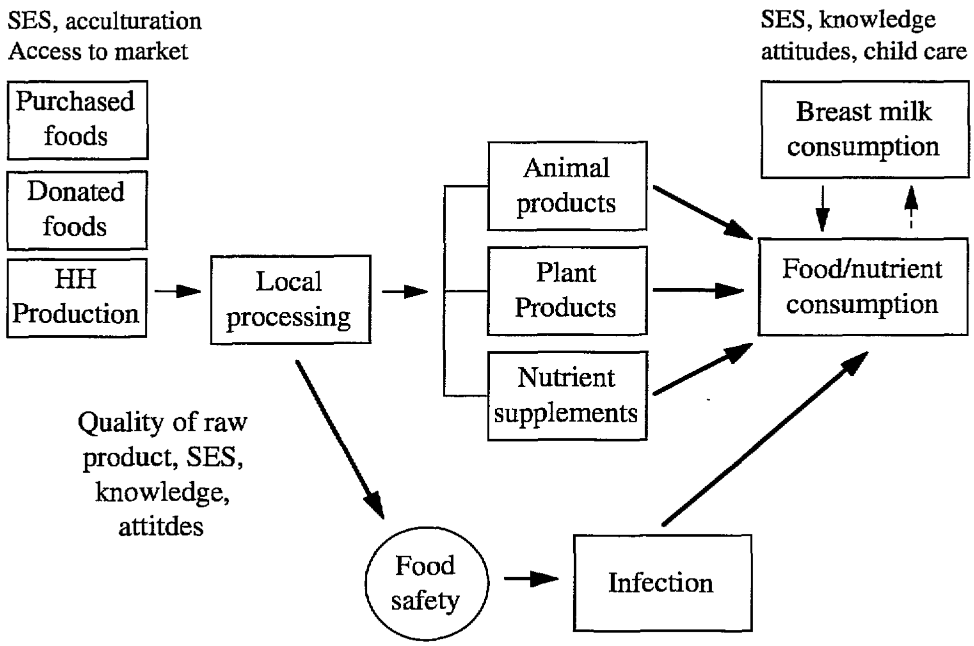


Figure 3: Problem Model 3.

products to promote for young children, and 4) prepare a detailed proposal for the future research program. Each of these activities has been successfully completed.

Progress

During the first phase of the current GL-CRSP project, our Assessment Team convened two workshops and multiple small meetings. During the first workshop in Peru we visited animal production sites, small-scale food processing plants, and training facilities in the Northern sierra; and we carried out several separate focus group discussions with mothers of young children and with local farmers. These observations indicated some of the key factors limiting animal production and the consumption of animal products by young children, and highlighted specific needs for additional qualitative and quantitative research on current levels of animal production, children's dietary intake, and relevant cultural beliefs influencing these activities. Information was therefore obtained through a set of competitively awarded "mini-projects"

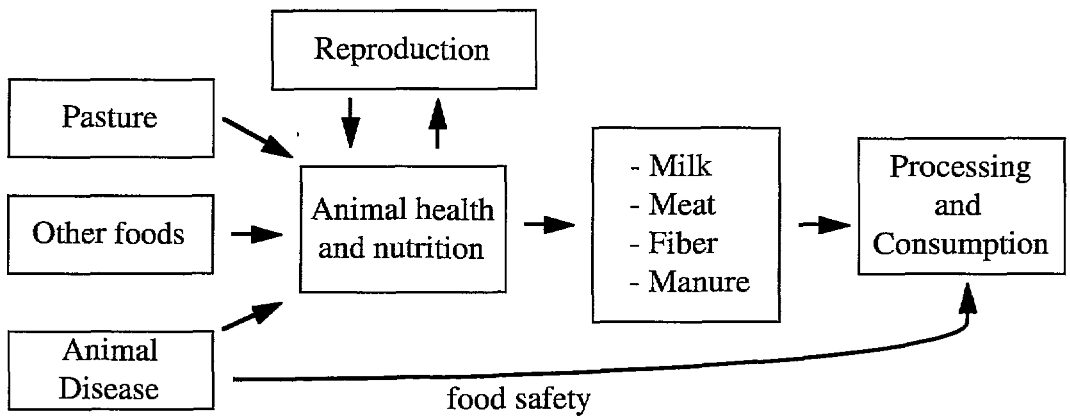


Figure 4: Problem Model 4 - Animal Production and Food Availability/ Safety.

that could be completed within the limited available time frame to broaden our knowledge base of the current situation and to prioritize future research needs. Four "mini-proposals" were approved for funding, as described below. Finally, a detailed review of literature was prepared on the effects of consumption of animal products on children's nutrition and health.

Economic Information

Agricultural economists from UCD established communication with colleagues at two institutions in Peru: Cuanto, a private economic and policy research institution directed by Dr. Richard Webb, and the Instituto de Investigación Nutricional (IIN), a private nutrition research institution headed by Dr. Lopez de Romaña. The researchers obtained a copy of the data tape from the Peruvian Living Standards and Measurement Survey (ENNIV 1994), which was carried out by Cuanto for the World Bank. This survey provided detailed information on 3,623 households and 19,284 individuals, of whom approximately 40% live in rural areas. Included in the data are approximately 2,800 children under 5 years of age. Data are available on animal production, total and disaggregated food expenditures (including animal products), and anthropometry for children under 5 years of age. Preliminary analyses have been completed on 1) the total and average per capita production of livestock at the regional level for each type of animal and for the aggregate, and 2) the consumption of animal products for each household, by type of product and total. Analysis is continuing on the determinants of household animal product consumption, including socioeconomic status and household animal production.

During this preliminary exercise, several advantages and shortcomings of the ENNIV 1994 data set were identified. Its major strengths are the nationally representative sampling design and large sample size. However, the dietary intakes were reported as amount spent on food (or imputed value of home produced food); intakes were not measured directly. Moreover, consumption data in the ENNIV 94 survey are available only for the household, whereas we are primarily interested in consumption by the individual child. We are also particularly interested in the source of animal foods consumed by the children (whether purchased, produced by the household, or provided by social welfare programs). For these reasons, during the next phase of the project we will conduct a combined sample survey and focused ethnography of household animal production and dietary intake by young children in a small number of communities intentionally selected for their ecologic niche (valley or high plains) and access to markets.

Production Systems Case Studies

Preliminary information was collected from a convenience sample of four production systems (two commercial and two household) in the *departamentos* of Junin and Pasco to determine the reproductive efficiency, milk production rates, and sales of dairy cattle and to develop preliminary statistical models to assess factors limiting production. Birth rates were considerably less than expected in all sites (approximately 30%) and milk production was very low (approximately 1.0-1.5 liters per cow per day). These findings are both consistent with poor animal nutrition and health, which will be examined in greater detail during the next phase of research. The data obtained during these surveys are still under analysis.

Food source	% of non-breastmilk energy
Powdered milk	5.2
Evaporated milk	4.3
Fresh milk	1.7
Cheese	0.1
(All dairy)	(11.3)
Egg	1.5
Red meat	0.6
Chicken	0.5
All animal products	14.1

n = 412

Table 1: Energy intake from animal sources by children 6-24 months, Ancash-Sierra, Peru

Dietary Intake Studies

Data were analyzed from quantitative 24-hour dietary recall histories obtained during July-August, 1996 from 412 children from 6-24 months of age in the Ancash-Sierra department. A total of only 14% of non-breast milk energy was consumed from animal products, primarily from processed milk; 42% of children received no animal products on the day of observation (see Table 1 and 2). Little red meat or cheese was consumed. Children who consumed higher amounts of animal products (upper quartile of intake) had greater intakes of energy, protein, vitamin A, calcium, and zinc than those who did not consume animal products.

Ethnographic Studies

Preliminary ethnographic studies were conducted in collaboration with UNALM in two rural communities, Corpacancha (elevation: 4,200 meters above sea level) and Pachacayo (elevation 3500 meters), both of which are located in the *departamento* of Junin. The purposes of the studies were to explore the perceived suitability of different animal products for young children and to learn more about the function of community organizations that could be enlisted in future intervention programs. The selected communities are administrative centers of rural agricultural development projects (SAIS), which were established during the period of the agrarian reform to stimulate cooperative development. The project in Corpacancha is currently operated as an *empresa multi-comunal* ("SAIS Pachacutec"), which is a private agricultural enterprise owned by the community and managed by engineers hired by the *empresa*. The activities in

Nutrient	Intake (% required from complementary foods)		% of children with low intake	
	Non-consumers	High animal intake*	Non-consumers	High animal intake*
Energy	74	92	73	67
Protein	288	413	42	9
Vitamin A	77	544	59	54
Calcium	29	124	96	48
Iron	43	45	89	92
Zinc	21	42	99	98

* Upper quartiles of energy intake from animal products (49% of infants 6-11 mo. and 42% of children 12-24 mo. consumed no animal products)

Table 2: Intake of selected nutrients from complementary foods by children 6-24 m of age, according to intake of animal products- Ancash-Sierra, Peru

Pachacayo fall under the direction of the SAIS Tupac Amaru, with its center in the province of Jauja. The *empresas* supervise cooperative animal production and some food processing, mainly of milk and cheese, although some of these activities are also carried out at the household level. A portion of the food produced by the *empresa* is distributed to its employees and other members of the community through a system of "concessions" whereby each family receives animal products—cheese, butter, meat) weekly or monthly at a reduced price. Many reported that some, if not all, of these concessions are sold for cash rather than consumed directly by the beneficiaries. This system of concessions is a potential channel for distribution of animal products to the participating families, but the current limitations need to be addressed.

This preliminary assessment further indicated that the *empresas comunales* vary from one setting to another, both in their organization and their relationships with the participating communities. In Corpacancha, for example, the *empresa* functions more like a pure commercial venture than a traditional community development organization. This presents difficulties for the implementation of interventions as there is considerable migration of the population, many employees live there without their families, and the pastors themselves live a nomadic life.

As indicated by the aforementioned dietary survey data, mothers confirmed that small children are generally not given animal products except milk until well into the second year of life. Interestingly, mothers also reported some concern for the safety of animal products, because of diseases of the animals and chemicals that are added during processing (particularly of cheese). From these observations we have tentatively concluded that the most appropriate animal products to be promoted for small children should be based on pasteurized milk. The *empresas comunales* need to be explored further as potential channels for intervention, particularly to see how they can be more effective in improving their productivity and direct benefits to the community.

Revised Problem Model and Future Activities

Based on these sets of findings of the AT, we have revised our PM as follows:

1) Because of the severely constrained household resources, it appears to be unreasonable to expect that animal products, which are currently being sold to generate income, will be diverted for children's consumption unless the total level of production can be augmented or household income can be elevated. Thus, our team will develop integrated programs to enhance the efficiency of livestock production and processing of animal products, while simultaneously developing methods to promote increased consumption of these products by young children. Given the low levels of productivity being realized at present, this appears to be a feasible goal. To achieve this will require a concerted effort on several fronts relating to livestock productivity, including improving nutritional and health status, ecosystem management, and genetic potential.

2) It is not known whether the best way to increase children's consumption is by means of a) greater household or community livestock production, b) increased household income, or c) social welfare programs and nutrition education that target young children. Because of this uncertainty, one of the team's first research activities will be to study the relationships among household socioeconomic status, household and community production of livestock, and consumption of animal products by young children. We will simultaneously explore the ability and interest of existing community organizations, such as *empresas comunales*, to channel some of their production for children or serve as conduits for delivery of these products.

3) Results of focus group discussions and analysis of children's dietary intake indicate that the primary animal products currently consumed by young children or deemed most suitable for them are dairy products and possibly eggs. Very little meat is consumed in general, and children are usually not given any meat until well into their second year of life. Moreover, child care givers were reluctant to invest in household egg production because of the reportedly high incidence of diseases that decimate their poultry. For these reasons, we have decided to focus primarily on the production of dairy cattle and processing of milk products. Importantly, children who were consuming more animal products were consuming less breast milk. Although the causal direction of this relationship is uncertain, these results indicate the need for great caution in delivering animal products to ensure that they do not displace breast milk.

4) Small-scale milk processing plants exist in a number of communities, but these facilities are rudimentary and food safety is questionable. Further investigation is required on a) the composition and microbiological quality of milk by type and nutritional status of cows, ecologic setting, and season of year, and b) the range of available processing facilities. This information will be used to determine the types of milk processing that may be feasible and most appropriate in the future. Because iron and zinc are critically limiting nutrients in the children's current diets and milk is a relatively poor source of these nutrients, locally appropriate methods of fortification must be developed where meat products are not acceptable for children.

The proposed research activities for the next phase of the GL-CRSP have been divided into four major components. Each research component represents the primary disciplinary expertise and associated research infrastructure that are required for the associated subprojects. The specific research components are 1) socio-economic and ethnographic research, 2) animal production and animal health, 3) food processing, and 4) human nutrition. Field activities will be based primarily in the Central Sierra of Peru for several reasons: 1) this area is the geographic center of the three Andean countries of major interest; 2) the geography is sufficiently variable (with regard to Andean valleys and high plateaus; greater or lesser access to markets) that the research results will be applicable to the entire Andean region; 3) this area was the site of previous SR-CRSP activities, thus permitting access to community

Objective 1: To develop appropriate interventions to increase consumption of animal products by young children

Outputs	Impacts	End User	Actions Required	Team Members	Time to Completion
Information on milk composition and microbiological safety by type of animal, production system, and season of the year.	Increased availability of safe, nutritious milk-containing products for young children	Farmers, community organizations, development agencies, government, industry	Collection and chemical and microbiological analyses of milk specimens obtained at different times of the year.	Rosenberg, Singh, Hird; Salas, Vargas, Tellez	3 years
Information on current milk processing knowledge and capability.			Survey of food processing techniques used at household levels.		
Development of safe and nutritious milk-derived products for young children			Development and acceptability testing of prototype food products containing milk.		

Objective 2: To improve the nutrition, health, and productivity of dairy cows in the Andes

Outputs	Impacts	End User	Actions Required	Team Members	Time to Completion
Information on feasibility and nutritional impact of improved range management, use of animal feeds (silage)	Improved range management and animal nutrition	Farmers, community organizations, development agencies, government agencies	Develop field research station, collect data on feed supply, herd dynamics, production process, and product end points Collect data from abattoirs, physical examinations, and serological survey on prevalence of major animal diseases, and develop pilot disease control interventions. Develop analytic model of factors influencing animal production	Sainz, Hird, Fadel, Jarvis; Flores, Gamarra, Gutierrez, Ramirez	4 years
Information on animal health	Identification and control of major diseases				

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organizations and field staff that participated in that project; 4) UNALM has established its primary research and training field stations in this area; and 5) there is reasonably easy access to the field sites from the participating research institutions.

A separate administrative core will be devoted to management of the combined program, including facilitating communication among team members and dissemination of information. We will explore use of the Internet for scheduled monthly teleconferences to present an update on the progress of each component of the project. We will also convene annual meetings of the full team in Peru to facilitate close interaction among scientists in each research component and to assure that the individual research activities remain focused on and relevant to the primary objective of developing interventions to improve young children's nutrition and health. The time line of each component has likewise been planned to provide results in timely fashion for incorporation into community-based intervention activities during the second half of the presumed six-year funding period. Periodic regional meetings will also be scheduled in collaboration with the CONDESAN network (described below) to enable input from scientists and policy makers in the Andean region and to facilitate regional dissemination of information.

Abstracts, Presentations, Workshops

December 3: Workshop - UC Davis Assessment Team. Small Ruminant CRSP Orientation

January 20 - 24: Workshop - Lima, Peru. "Assessment of the importance of animal products for the nutrition of young children in the Andean region: team building and identification of appropriate animal products"

February 20: Workshop - UC Davis Assessment Team. Development of Mini-proposals

March 5: Program in International Nutrition Seminar. Dr. Ken Brown, PIN Director, speaking on the current Small Ruminant CRSP project in Peru entitled "Assessment of the importance of animal products for the nutrition of young children in the Andean region"

April 18: Workshop - UC Davis Assessment Team. Presentation and Update on Mini-Proposal

April 23: Program in International Nutrition Seminar. Ken Brown, PhD and Marjorie Haskell, PhD. Nutrition Effect of animal products on the nutritional status and behavioral development of infants and children. Design of Small Ruminant CRSP efficacy trial.

May 28: Program in International Nutrition Seminar. Tu Jarvis, PhD. Agricultural Economics/IAD Economic determinants of household animal production and consumption in Peru.

June 4: Program in International Nutrition Seminar. Roberto Sainz, PhD. Animal Science. Analysis of livestock production in the Andes (the SR-CRSP).

June 9 - 13: Workshop - Davis, CA. Discussion of results of pilot project entitled “"Assessment of the importance of animal products for the nutrition of young children in the Andean region: team building and identification of appropriate animal products." Discussion of Global Livestock CRSP formal proposal development

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United States			
Brown, Kenneth Principal Investigator, Professor	University of California, Davis	Nutrition	American/USA
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Bradford, Eric	University of California, Davis	Animal Science	American/USA
Brush, Stephen	University of California, Davis	Anthropology	American/USA
Dewey, Kay	University of California, Davis	Anthropology	American/USA
Enlge, Patrice	Cal Poly	Psychology	American/USA
Fadel, James	University of California, Davis	Animal Science	American/USA
Haskell, Marjorie	University of California, Davis	Nutrition	American/USA
Hird, David	University of California, Davis	Veterinary Medicine and Epid.	American/USA
Jarvis, Tu	University of California, Davis	Agricultural Economics	American/USA
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Singh, Paul	University of California, Davis	Food Science and Technology	Indian/USA
Taylor, Ed	University of California, Davis	Agricultural Economics	American/USA
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Cueto, Santiago	Insituto de Investigacion Nutricional	Psychology	Peruvian/Peru
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Gamarra Bojorquez, Jorge	Universidad Nacional Agraria-La Molina	Animal Science	Peruvian/Peru

Team Member Name	Affiliation	Role/Discipline	Nationality/Residence
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Salas V., Walter Francisco	Universidad Nacional Agraria-La Molina	Food Science	Peruvian/Peru
Tellez Villena, Jose G.	Universidad Nacional Agraria-La Molina	Food Science	Peruvian/Peru
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Carrasco, Alfonso	ITDG	NGO-Food Science	Peru
de Romana, Maurico	Proyecto Especial Tambos Alpaqueros	NGO	Peru
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Ruel, Marie	IFPRI	Nutrition	Canadian
Webb, Richard	Cuanto	Economics	Peru

LINDA: Livestock Information Network Development for the Americas

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Narrative Summary

Decision making by producers, agribusinesses, policy makers, and consumers in LA livestock sectors is severely inhibited by the lack of accurate and timely information relevant to those decisions. Historically, much of this information for Los Angeles countries has been either unavailable or difficult and costly to obtain. The overall goal of the LINDA project is to develop and implement a self-sustaining, comprehensive network of research, technology development, and training to provide access to information through an enabling information system for decision making at all levels in U.S. and Latin American livestock sectors. During the assessment phase, the AT focused on developing a prototype of the LINDA system in Mexico and establishing the groundwork for full implementation of LINDA in Mexico and expansion of the system into other LA regions. Emphasis in the LINDA system prototype development has been on providing small producers and policy makers with greater access to information needed for more informed decision making. The LINDA system consists of three interrelated components: (1) research, (2) Internet-based information technology, and (3) training. The research component relates directly to the identified areas of needed information. In each region, research will be funded to fill information gaps identified by an assessment of information needs and sources and the research results will be made available through the LINDA information system and indexed in the searchable research database of the information system. Internet-based information technology is the core of the LINDA system. The main component of this technology is a wide area network (WAN) of information databases within the LINDA system that (1) provides centralized access to information maintained by various providers and (2) enables efficient dissemination of information through new (Internet) and existing information distribution mediums (television, radio, fax, producer associations and newsletters). LINDA will not provide simple links to other web sites but rather will create a centralized system of information databases that are searchable by various keywords across regions, time, products, livestock types, and other categories. The training component of the LINDA system will consist of training for U.S. and Latin American students, in-country

collaborators, and information providers and users on the development and use of information technology and its application in the LINDA system for ranch, farm, market, and policy decision-making. Once the LINDA system prototype is implemented in Mexico during the first full year of the project, the system will be expanded into the Central American region in the second year and then into the Andean region of South America in the third year. The AT has received the overwhelming and enthusiastic support of a wide range of information providers and users for the LINDA system concept. The LINDA system prototype has now been developed, the necessary groundwork has been set, and collaborative arrangements have been made to greatly facilitate the implementation of the system in the next fiscal year if funding is provided.

Problem Model

Perhaps the fastest-growing, most limiting impediment to development in the livestock sectors of Latin American (LA) countries is access to information by decision makers at all levels. Efficient, profitable livestock production, processing, marketing, trade, and policy decisions require a wide range of information on markets, animal health management and nutrition, the environment, agricultural resource use and sustainability, agricultural and economic policy, alternative production systems, food marketing and distribution, and more. Unfortunately, however, such decision making is severely inhibited by the lack of accurate and timely information relevant to those decisions. Historically, much of this information for LA countries has been either unavailable or difficult and costly to obtain. What is available is not generally accessible by the vast majority of small producers and other potential users. In recent years, the amount, type, and quality of information that LA livestock producers, processors, marketers, consumers, and policy makers must acquire and assimilate have increased many fold as a result of growing global and regional trade liberalization, rapid changes in global and national financial and commodity markets and food consumption patterns, pervasive changes in domestic and global agricultural and macroeconomic policies, and significant economic structural change within and outside the hemisphere. New, rapidly emerging issues, such as the relationship between livestock products and child nutrition in developing countries, food safety, new production and processing systems and technologies, and expansion of the North American Free Trade Agreement (NAFTA) to include more of Latin America, will intensify the pressure to acquire critically needed information for appropriate market and policy decisions to maintain the economic viability of LA livestock sectors and, thus, achieve greater economic growth, lessen environmental impacts, and improve nutrition.

At the same time, as economic integration of the U.S. with Mexico and the rest of Latin America proceeds, the agricultural and general economies of these countries are becoming increasingly interdependent. Consequently, policy shifts, market changes, regional realignments, and economic adjustments in Latin America all have increasingly significant impacts on decision making in the U.S. For example, the implementation of NAFTA has opened U.S. markets to large and growing imports of feeder cattle while also opening Mexican markets to U.S. exports of breeding cattle, genetic material, livestock products, and grains. U.S. decision makers at all levels, thus, have a critical and rapidly growing need for difficult to obtain and generally unavailable information on the livestock sectors in Latin American countries.

The overall goal of this project is to develop and implement a self-sustaining, comprehensive network of research, technology development, and training to provide access to information through an enabling information system for decision making at all levels in U.S. and Latin American livestock sectors. Information needed for the system includes not simply production, consumption, trade, and price data but also a wide range of technical information on animal health and nutrition, human nutrition, new processing and production technologies, alternative small farm production systems, the environment, agricultural and national economic policies, food safety and quality, and more. Some of this information is available and generally accessible but much is either available but not easily accessible or is simply not available. Region by region in Latin America, this project will (1) establish collaborative relationships with information providers and user groups[1], (2) identify and access the needed and available information through the established collaborative arrangements, (3) establish collaborative research projects with in-country information providers and users to generate needed but not available information, (4) develop the information technology to accumulate, process, and disseminate needed information to decision makers at all levels with emphasis on accessibility of this information by small producers and policy makers, and (5) provide training both to U.S. and LA students in information collection, analysis, and dissemination technology and systems and to information providers and users to optimize the use of the system.

This project grew out of our extensive experience in working with both users and generators of information in Latin America. Over the years, we have observed that the absence not only of reliable and timely information but also of sound, adequate information collection and dissemination systems has been a major complaint of decision makers and a serious impediment to decision making in these countries. The lack of adequate, timely information has severely curtailed the competitiveness of LA livestock producers, contributed significantly to the inefficiency of LA livestock markets, led to inappropriate policy prescriptions, constrained the rate of economic growth in the hemisphere, and hampered efforts to deal effectively with environmental and human nutrition concerns. Particularly disadvantaged have been small producers who lack access to critical information to improve their economic and nutritional well being. Every effort has been made to design the system based on the input of user groups and information providers so that the system meets the needs of each group at all levels.

Assessment Team Process and Progress

Overview of Proposed Assessment Team Activities

The activities of the multidisciplinary LINDA Assessment Team (AT) over the last 9-month period were to have focused on (1) developing a prototype of the LINDA system in Mexico, (2) creating the initial network of LINDA contributors and users particularly in the US and Mexico to promote development of the LINDA prototype but also in Central America and the Andean region of South America to facilitate future work, and (3) designing a subsequent 3-year program of research, training, and solicitation of buys-ins to sequentially replicate, expand, and support the LINDA prototype across and within not only Mexico but also two other broad regions of Latin America (Central America and the Andean region of South America). To accomplish these tasks, the LINDA Assessment Team was to be divided into two interactive groups. Members of Group I were to have the technical expertise in designing and constructing comprehensive information systems. Members of Group II were to have the knowledge and experience regarding the key impact areas in LA livestock sectors. Group I was to design the prototype of the LINDA system for Mexico while Group II was to establish collaborative arrangements and conduct field activities (i.e., focus group interviews) to identify information providers and users and determine information needs for the support of the design and development of the LINDA prototype. In addition, according to their various areas of expertise, members of Group II were to be tasked with working through collaborators to identify potential sources of needed information, define areas of needed research, recommend needed components of training programs related to the development and implementation of the LINDA system, and identify additional sources of funding. Groups I and II were to interact at several levels to (1) further define their respective roles, (2) identify key policy impacts and information needs and sources, (3) plan and carry out the field activities, and (4) assess what was learned from the development of the LINDA prototype for the design of a subsequent 3-year program of replication and expansion of the LINDA system from Mexico into Central America and the Andean region of South America. Also, the two groups were to develop a system of monitoring and evaluation of the LINDA impact in each region. Finally, each group was tasked with meeting in smaller groups as necessary to identify prospective collaborative arrangements, potential buy-ins, and more detailed development of information needs in key impact areas. At each point, the primary concern was to have been identifying and interacting with information providers and users to determine information needs and to design the LINDA system for maximum functionality and performance.

Assessment Team Progress

The AT process performed extremely well in achieving all objectives planned for the initial 9-month study period. In addition to meetings of the full AT, an electronic communication network among all AT members was developed which greatly facilitated a rapid exchange of ideas, comments, reports on task assignments, and recommendations for system design modifications and expansion. The activities to achieve the project objectives were completed in several steps referred to as the LINDA information process which will be replicated in each country/region in which LINDA is implemented if the full project is funded. Following a discussion of the LINDA process, more detail on the work accomplished by the AT in designing the LINDA system prototype is provided.

The LINDA Information Process

Selection of the main collaborating research institution. A key to the successful design of the LINDA prototype and of future implementation of the LINDA system in Mexico was the selection of a main collaborating research institution to assist in identification of information users and providers, help develop collaborative relationships with key government, private, academic, and producer groups, provide guidance on research and training needs and procedures, and preserve continuity from system design through implementation. Selection criteria included: (1) thorough knowledge of the Mexican livestock sector, (2) extensive contacts with livestock information providers and users at all levels, (3) a reputation for solid objective research in some area of animal agriculture, (4) access to adequate technology, training extensive search, the AT selected the Center for Economic, Social, and Technology Research on World Agriculture and Agribusiness (CIESTAAM) at the Autonomous University of Chapingo (UACh) near Mexico City as the main collaborating institution for development of the LINDA prototype during the 9-month assessment period and during the full implementation of LINDA in Mexico if the full project is funded. The UACh is the leading agricultural university in Mexico and CIESTAAM has a widespread reputation as a serious, competent research group with many years of experience on Mexican livestock market research and extensive connections within the Mexican livestock sector at all levels. The CIESTAAM director and research coordinator became members of the AT to facilitate collaboration.

Identification of key information providers and users. Working with the main collaborating research institution, the AT identified key sources of livestock information and potential users of that information among six broad categories: (1) government agencies/policy makers, (2) major livestock researchers and research institutions, (3) livestock producers and producer associations, (4) agribusinesses, and (5) consumers. Once the specific groups in each category were identified, each was approached through presentations and focus group interviews to assess information needs and sources, to establish collaborative arrangements for information access and dissemination, and to develop additional funds for leveraging the project. The key identified information sources and users are discussed below in terms of their collaborative contributions to the project.

Assessment of information needs and sources - For development of the LINDA prototype during the 9-month assessment period, the AT, working closely with CIESTAAM, assessed the information needs and availability for the Mexican livestock sector at all levels through extensive field work and focus group interviews with the identified key information providers and users in Mexico. In this way, needs and availability of information in three broad areas were determined: (1) needed information that is readily available and accessible from one or more sources, (2) needed information that is available but not easily accessible (and generally not in a useable electronic format), (3) needed information that is not available. A list of the interviews done and presentations made is included in a later section.

Design of the LINDA prototype system. Based on the information needs and sources assessment, and working with the in-country collaborating research institution, the LINDA prototype was designed by the AT to include three main components: (1) research, (2) information technology development, and (3) training as discussed in more detail below.

Development of collaborative arrangements/buy-ins. Working with the identified key information providers and users, the AT has worked to develop the arrangements and buy-ins necessary to formalize relationships, secure access to information, establish mechanisms for accessibility of information through the LINDA system, and cultivate alternative sources of LINDA development and maintenance funding. Demonstration of the LINDA system prototype developed by the AT was the key to securing the needed arrangements and buy-ins. To this point, collaborative arrangements to provide access to needed data, to assist in dissemination of LINDA system information, to provide leveraged funds have been established with numerous groups. A full list of collaborators is provided in a later section.

Potential Leveraged Funds

The following groups/firms have indicated the likelihood of leveraged funds contingent on the approval of this project by USAID: (1) National Cattle and Beef Association (NCA), (2) Koch Agriculture Company, (3) Purina, S.A., Mexico, (4) Nestlé, (5) Anderson-Clayton, (6) Bancomer, S.A., (7) Inter-American Development Bank through the Informatics 2000 initiative in connection with a joint LINDA/AGROINFO effort, (8) Ecuador Ministry of Agriculture and Livestock in a World Bank funded information system project in Ecuador (Proyecto SICA).

Implementation of the LINDA system. Given the design of the LINDA system, the development of the LINDA prototype, and the necessary collaborative arrangements, the AT worked to establish a basis for implementation of the LINDA system during the next phase of the project if funded. These efforts included work to develop connectivity to existing sources of information and to establish in-country information networks to efficiently disseminate information through the LINDA system as broadly as possible to insure accessibility of the information to the smallest producers as discussed in more detail below.

Evaluation of the LINDA impact. As one facet of the development of the LINDA system prototype, the AT has worked to devise a system for

Table 1: Groups collaborating on access to data

SAGAR, Centro de Estadisticas Agropecuarias, Mexico	
Data to be provided:	production (carcass, meat, dairy), demand, producer prices, yields by species and states, situation and outlook reports
Other collaboration:	(1) labor and resources to make SAGAR data files compatible with LINDA Internet database requirements, (2) labor and resources to up-load and maintain growing volume of data on the LINDA system
INEGI (Instituto de Estadistica, Geografia e Informatica), Mexico	
Data to be provided:	(1) livestock inventories and census data by region, structure, activity, purpose, technological, and management level, (2) results of a national survey on livestock information users and providers
Other collaboration:	Use of agency resources and technical personnel
SECOFI (Secretaria de Comercio), Mexico	
Data to be provided:	trade and macroeconomic information
Banco de Mexico-FIRA, Mexico	
Data to be provided:	Credit lines, distribution and requirements, interest rates, production costs
SNIM (Servicio Nacional de Informacion de Mercados), Mexico	
Data to be provided:	Basic set of livestock, meat and dairy wholesale prices in major Mexican markets by specie and product
SEMARNAP (Servicio Nacional del Medio Ambiente, Recursos Naturales y Pesca), Mexico	
Data to be provided:	Access to the Information Network on Soil Management and Deforestation
Other collaboration:	Use of agency resources and technical personnel
CNG (Confederacion Nacional Ganadera), Mexico	
Data to be provided:	CNG estimates of livestock inventories by state, specie, brand
Other collaboration:	Use of regional and municipal offices, personal, and computer technology to disseminate LINDA system information to their 1,000,000 producer members throughout Mexico and to provide training in the use of LINDA and information technology
USDA-ERS (U.S. Department of Agriculture - Economic Research Service), United States	
Data to be provided:	Access to extensive USDA data on U.S. livestock production, inventories, inputs, and other information including situation and outlook reports
Other collaboration:	Work with LINDA project to provide SAGAR with equipment and training to improve quality, availability, and timeliness of livestock information to be disseminated though LINDA
Purina, S.A., Mexico	
Data to be provided:	Basic extension packages on animal nutrition and health issues and small farm production technologies
Bancomer, S.A., Mexico	
Data to be provided:	Information on natural resource administration related to livestock production in Mexico
AFPC (Agricultural and Food Policy Center), Texas A&M University, United states	
Data to be provided:	Information on US and LA information on livestock-related domestic and trade policies

monitoring the impact of the LINDA system on the target areas (economic growth, the environment, and human nutrition), for insuring feedback from information users and providers to the design and operation of the LINDA system, and for assessing the quality and type of information to be made available through the LINDA system.

Expansion and Regionalization of the LINDA system. During the next phase of the project, if funded, the full LINDA system will be implemented in Mexico based on the prototype developed during the assessment phase and then expanded and implemented sequentially in other LA regions, including Central America and the Andean region of South America. The AT has worked to set the groundwork for the implementation of the full LINDA system in Mexico as discussed above and for expansion of the system into other Latin American regions. Four key activities by the AT will facilitate future implementation of

Table 2: Groups collaborating on information dissemination

CNG (Confederacíon Nacional Ganadera), Mexico	
Collaboration:	(1) Assistance in distribution of LINDA information to member producers through its 82 regional offices and 1,000 municipal level offices, many of which are equipped with computers and Internet access (2) Use of regional and municipal offices and staff for training of member producers in information technology and the use of LINDA system for decision-making.
SAGAR, Centro de Estadistica Agropecuaria, Mexico	
Collaboration:	(1) Use of their 32 state offices throughout the country to promote LINDA use and training, (2) use of their 946 radio station network to reach farmers without computers and Internet access to the LINDA system.
SAGAR, Direccíon General de Desarrollo Ganadero, Mexico	
Collaboration:	Use of LINDA network to disseminate key animal health, policy and technology information to small farmers
Purina, S.A. and Anderson-Clayton, Mexico	
Collaboration:	Use of their national networks of distributors and consultants to promote the use of LINDA and disseminate basic extension packages.
Institute for Cooperation in Agriculture), Costa Rica/Washington, D.C.	
Collaboration:	(1) Use of Latin American network to promote the use of LINDA system, (2) use of agency resources and personnel to develop joint information system of agricultural information (AGROINFO and LINDA) for Latin America
Universidad Autonoma Chapingo	
Collaboration:	Use of their facilities, resources, and personnel for training students, information providers, researchers, and other users in the use of LINDA
Texas A&M University	
Collaboration:	Use of the Texas A&M University Center and center equipment in Mexico City for training workshops

LINDA in other LA regions. First, members of the AT have worked to determine information sources and needs and to develop collaborative arrangements in Belize with both government and private sector participants. The Ministry of Agriculture in Belize is initiating an information technology project and is anxious to join forces with the LINDA project. Second, AT members have also worked extensively to establish collaborative arrangements between the LINDA system and the information system initiatives of the Inter-American Institute for Cooperation on Agriculture (IICA) based in Costa Rica with offices in 34 countries in the Western Hemisphere and the Caribbean/Latin American Action (C/LAA), a non-profit, private organization headquartered in Washington, D.C. that promotes private-sector-oriented economic development in the region. The IICA and C/LAA are collaborating on the development of an Internet-based information system known as AGROINFO (http://www.agroinfo.org/) which is to be expanded and enhanced with funding through the Informatics 2000 Initiative of the Inter-American Development Bank (IADB). The AT has worked out the arrangements for a joint effort between the LINDA project and the AGROINFO initiative with buy-in from the IADB. The IICA and the C/LAA have agreed to write a joint letter supporting funding of the LINDA system and expressing their commitment to a joint effort. Arrangements will be finalized in a meeting between members of Group I of the AT and representatives of IICA and C/LAA at Texas A&M University on July 10[2]. Third, AT members have worked to determine information needs and sources and to establish collaborative arrangements in Panama, particularly with the 19 major cattle producer and processing groups many of which include small and medium-sized producers as members. In addition, AT members have worked with Panama's leading Internet service providers (CYBERMEDIA) to determine Internet capabilities and needs in Panama. Fourth, the AT is finalizing arrangements with the Information System and Agricultural Census Project (PSICA) of the Ministry of Agriculture and Livestock in Ecuador which is funded by a large grant from the World Bank. The purpose of PSICA is to build an information service for the private sector, improve public agricultural policy, and execute the agricultural census in Ecuador. Collaboration with PSICA will provide the basis for the implementation and expansion of the LINDA system in the Andean region.

LINDA System Design

The LINDA system consists of three interrelated components: (1) research, (2) Internet-based information technology, and (3) training .

Research component: The research component of the LINDA system relates directly to the identified areas of needed information that is not currently available. In each region, the AT will issue a call for proposals to conduct the needed research as identified by the assessment of information needs and availability. Results from the funded research will be made available to users through the LINDA information system and indexed in the searchable research database of the information system. The LINDA budget must include funds for this purpose for each country/region.

Information technology component: Internet-based information technology is the core of the LINDA system. The main component of this technology is a wide area network (WAN) of information databases within the LINDA system that (1) provides centralized access to information maintained by government, university, producer, and private groups and (2) enables efficient dissemination of information through new (Internet) and existing information distribution mediums (television, radio, fax, producer associations and newsletters) within a developing country context. Thus, LINDA will not provide simple links to other web sites but rather will create a centralized system of information databases that are searchable by various keywords across regions, time, products, livestock types, and other categories. Development of the electronic interfaces to access data in existing computer networks and database systems is necessary to create a central database from which reports and analysis can be generated.

In considering opportunities for information dissemination directly to users through the Internet, the AT conducted a review of telecommunications and information technology resources in LA and found that the high-speed connectivity to the Internet required by wide area networks and database servers (T3, T1, and ISDN) is not available through most of LA and will take substantial resources to develop. However, single-user dial-up access through existing telephone lines was found to be readily available and growing rapidly. Also, livestock sector information within LA can be found in every format from hardcopy to single-user database systems. Like the US government, these information sources were designed for internal reporting and limited distribution. The focus on internal reporting means that there is no central information system dedicated to providing public access to livestock information. In the LINDA prototype, organizations without the resources to maintain a server with high-speed access to the Internet can utilize local dial-up connections to the Internet and password-protected access to the LINDA information server and server-side applications to promote their organizations. Server-side applications provide access to databases and tools that execute on the server without requiring any software on the user's personal computer other than a web browser. Each organization will have access and control of user-friendly and technically sophisticated applications without the expensive server, software, connectivity, and programming investment. The database structure and information tools will be migrated to organization information servers as Internet access evolves in LA.

For those users without direct Internet access, the LINDA information system will provide the technology for automated dissemination of information in various formats to fax machines for individual users and for redistribution through various existing communication systems, i.e., radio, newspaper, television, etc. For example, automatic transmittal of information from the LINDA system to the network of over 946 radio stations in Mexico will provide complete coverage of the target market with new and previously unavailable information for decision making by small producers. SAGAR has committed to the use of their information network of 32 state offices to distribute LINDA system information to small producers and agribusinesses. At the same time, a collaborative arrangement with the Mexican Confederación Nacional Ganadera (the National Confederation of Livestock Producers) will allow over 1,000,000 small livestock producers throughout Mexico to access needed information through the LINDA system via the Internet connections in each of the 82 regional and many of the 1,000 municipal offices of the CNG. As indicated below, this collaborative arrangement also allows for training workshops for small producers through the municipal and regional offices of the CNG. Also, the private sector will collaborate in the dissemination of LINDA system information. For example, both Purina, S.A. and Anderson-Clayton have committed the use of their distributor and consultant network to deliver basic animal health, marketing, policy, and small farm production systems information from the LINDA information system to producers, feeders and processors throughout Mexico.

The prototype of the LINDA system features a core group of centralized databases in several areas of application: (1) research, (2) marketing, (3) policy, (4) environment and natural resources, (5) human health and nutrition, (6) livestock health and nutrition, and (7) industry communication.

Research Applications

Access to a central source of livestock researchers and research activities will enhance the communication, coordination and cooperative research efforts across organizations, regions and disciplines in the Americas. In the LINDA prototype, the research applications include the following two databases:

Research Database - A searchable, central repository of reports, manuscripts, and data from livestock research activities in the country/ region. Research can easily index their documents by the title, description, author(s), organization, keywords, and abstract and then upload the files directly to the research database or create hyperlinks to documents located on remote servers. Users can then search through the database by any one of the fields. Copyright issues can be addressed by distributing documents in an Adobe Acrobat Portable Data Format (pdf) which will allow users to view documents in their original hardcopy format while preventing changes and file conversions.

Research Linkages - Linkages to existing government, university, and private livestock research organizations and data sources will be provided within the system.

(2) Marketing Applications

Access to livestock market data, statistical analysis, and the fundamental infrastructure through which buyers and sellers can promote their products and services is a central feature of the LINDA system and necessary for the public and private support necessary for the continuing development of LINDA. The key database applications include the following:

Livestock Database - A searchable, central repository of livestock market supply, demand, trade, and price information. The technology provides the ability to generate custom data reports by livestock type, livestock product type, time period, and region. Group I of the AT has worked closely with government agencies, livestock producer groups, private industry, and universities to promote access to market information databases, create collaborative alliances, establish and resolve connectivity issues, and devise methods of Internet and Intranet database input, maintenance, online reporting, and modeling.

Statistical Analysis Database - Situation and outlook reports on livestock production, stocks, inventories, disposition, utilization, and prices from U.S. and LA government, industry, universities, and producer groups. Market reports on food product development and marketing in LA countries, foreign market opportunities for livestock and livestock product sales.

Producer/Agribusiness Database - A central industry database of livestock producers, agribusinesses, and industry association web sites that will provide the initial steps to livestock marketing and electronic commerce in the Americas. The development team will provide producer and industry association applications to automatically upload and populate the agribusiness database from their membership files. The server will then generate producer and industry web pages automatically from this database. Producers and agribusinesses with Internet access can easily update and change their web page from the industry database online through password protected access to the server from anywhere in the world.

(3) Policy Applications

A central repository of agricultural and food policy information by livestock, livestock product, region, organization, and trade private and public decision makers in at least two databases:

Trade and Tariff Database - A comprehensive database of trade and tariff information for every country in LA across all livestock and livestock product types.

Policy Database - A central database of policy information related to livestock in the LA country/region and in the United States primarily from government agencies and universities but also from the private sector as appropriate. The database contains detailed descriptions of government policies affecting livestock and analyses of those policies and their impacts on the livestock sector. Policy components included the following: (1) domestic farm programs, (2) credit programs, (3) conservation and environment programs, (4) international trade programs, (5) marketing programs, (6) nutrition, food assistance, and food safety programs, (7) land ownership policies, and (8) state enterprise/trading programs.

(4) Environment and Natural Resource Applications

Environmental Impact Database - A central database of information on the impact of livestock on the four most serious environmental problems in Latin America - surface water and irrigation degradation, ground water degradation, and environmental problems associated with deforestation (i.e., soil erosion, increased variability in stream flows, and loss of carbon sequestration). The information will come from national and international agency sources, research results, and government data.

Geographic Information System (GIS) Database - A repository of GIS data from satellite images that can be used to identify soil types, track conditions in livestock pasture conditions, determine potential for erosion, measure and compare precipitation across regions and over time.

(5), (6) Health and Nutrition Applications

Human health and nutrition database - A database of information on human health and livestock products, including information on toxicology, food safety regulations, information on meat and human nutrition, nutritional guidelines and the role of livestock products, results of dietary surveys, livestock product consumption patterns by socioeconomic variables, food labeling issues and requirements, etc.

Livestock health and nutrition database - A database of information on animal disease problems, issues, alerts, and treatments and information on animal nutrition recommendations, products, and services from research, government, and private sources. The database will provide a catalogue of diseases/ breeds and incidence by country, disease statistics by sector, information on tuberculosis, brucellosis, and mad cow disease, information from and links to the Animal Health Division of the Federal government, animal health/ sanitary regulations affecting imports and exports by country, and USDA approval requirements and contact information.

(7) Industry Communication Applications

Contact database - The contact database will provide a central point for communications with producers and agribusiness representatives in and related to the livestock industry. Users can quickly create a profile that includes name, organization, and contact information, along with an optional bio. The contact information will include the communication methods available i.e., mailing address, phone, fax, e-mail, Internet phone, chat, whiteboard, and video conferencing. Users can then search the database by the above criteria to identify and contact industry representatives. The LINDA information system will provide the capabilities for scheduling group communications through Internet phone conference calls, chat sessions, whiteboard applications, and video conferencing.

Industry Calendar - The livestock industry calendar of events will serve as a focal point for scheduling industry activities in LA. Users may search the industry calendar by title, description, region, organization, contact person, time, and date. Each event will include the ability to e-mail the contact organization directly from the calendar and to link events to web pages. The calendar will be maintained by representatives in remote locations through password protected access to the database. To ensure the calendar is utilized, each participating organization will have the ability to create a custom front-end into the calendar that displays only their activities and events. The main calendar will display activities and events across all organizations. The calendar can also be used to filter and generate press releases and information spots for specific time periods and regions and automatically distribute these spots through e-mail and fax to regional media.

Discussion Forum - The livestock discussion forum will facilitate producer and industry communications by subject while building a knowledge based resource for the livestock industry. Users can add discussion topics and publish e-mail messages to that discussion area for help and/or suggestions. Others can respond directly to the author of the message or post the message to the discussion group for public review. All topics remain in the database and can be searched by subject, content, author, and date. Like the industry calendar, the discussion forum can be moderated by representatives in remote locations through password protected access to the database. To ensure the forum is utilized, each participating organization will have the ability to create a custom front-end into the forum that displays only their discussion topics.

Training component: The training component of the LINDA system will consist of four parts: (1) degree and non-degree training of both U.S. and Latin American students at Texas A&M University including instruction in the development and use of information technology for farm, ranch, business, and policy decision making, (2) the training of the in-country collaborators in the development and use of information technology and its application in the LINDA system for decision making, (3) the training by the in-country collaborators of information users and providers in the utilization and maximization of the LINDA system for decision making, and (4) small livestock producer training workshops. In Mexico, training of the in-country collaborators and many of the information providers and users will be conducted at the Autonomous University of Chapingo in Texcoco, Mexico and at the Texas A&M University Center in Mexico City. Training workshops for small producers, agribusinesses, researchers and other information users outside the Mexico City metropolitan area will be held as needed in many of the regional and municipal offices of the CNG and in regional offices of SAGAR, Purina, and Anderson-Clayton.

Future Activities

If the LINDA project is funded, the AT will work to develop the LINDA prototype into a fully functioning system in Mexico and then expand the system into other regions of Latin America. The implementation plan follows the LINDA process established during the 9-month assessment phase with some minor modifications.

The LINDA Implementation Plan

The implementation plan will be followed first in Mexico and then repeated for other regions in LA according to the timetable below:

Selection of the main collaborating research institution - The plan is to continue working with CIESTAAM at the Automonous University of Chapingo. The relationship has been extremely fruitful and has produced significant results in terms of establishing collaborations and other aspects of the work of the LINDA AT. The same selection criteria will be used for selecting the main collaborating research institution in other LA regions as expansion of LINDA takes place.

Identification of key information providers and users - This task was essentially accomplished in the assessment phase for Mexico but will be replicated as LINDA is implemented in other LA regions.

Assessment of information needs and sources - Future assessment of information needs and sources in Mexico will be done as part of the feedback, evaluation, and system redesign process (see below). For other LA regions, an assessment of information needs and sources will proceed formal implementation of the LINDA system into those regions.

Design of the LINDA system - Future design of the LINDA system will be done as part of the feedback, evaluation, and system redesign process (see below) both in Mexico and in other LA regions into which LINDA is expanded.

Development of collaborative arrangements/buy-ins - The AT will continue to develop additional collaborative arrangements to insure access to needed data and promote dissemination of the LINDA information system in Mexico and in other LA regions as indicated in the implementation timetable.

Implementation of the LINDA System - During the 9-month assessment phase, the AT established a strong basis for rapid implementation of the LINDA system in Mexico during the next phase of the project if funded. The three components of the LINDA system (research, information technology, and training) will be fully implemented first in Mexico and then expanded to other LA regions according to the implementation timetable. Based on the assessment of information needs and sources in Mexico, the AT will implement a competitive program of research proposals to resolve key information problems identified. Continuing work will be needed to further develop connectivity to existing sources of information and to establish in-country information networks to efficiently disseminate information through the LINDA system as broadly as possible to insure accessibility of the information to the smallest producers. Small producer training workshops will be held around Mexico in collaboration with the Confederación Nacional Ganadera (CNG), the Ministry of Agriculture and Livestock (SAGAR), collaborating universities and extension groups, and private groups such as Purina, S.A.

Feedback, Evaluation, and Redesign of the LINDA System - The AT will implement a system for monitoring the impact of the LINDA system on the target areas (economic growth, the environment, and human nutrition), for insuring feedback from information users and providers to the design and operation of the LINDA system, and for assessing the quality and type of information to be made available through the LINDA system. The system will be based on survey evaluations of the LINDA system by information providers, users, collaborators, and funders.

Expansion and Regionalization of the LINDA System - After implementation in Mexico, the full LINDA system will be expanded and implemented sequentially in other LA according to the implementation timetable. The groundwork is set for the expansion of the system into other Latin American regions as discussed earlier.

Implementation Timetable

First year:

(1) Implementation of the LINDA system in Mexico where much of the work was concentrated during the assessment phase, (2) commence work with IICA and C/LAA to link the LINDA project and the AGROINFO initiative in Central America with buy-in from the IADB, and (3) field work by the AT to establish additional collaborative arrangements and buy-ins in Central America.

Second year:

(1) Implementation of LINDA system in Central America as a joint effort with IICA and C/LAA and utilizing additional collaborative arrangements established during the first year with particular emphasis in Belize, Panama, and Costa Rica where individual AT members have worked to set the groundwork for LINDA expansion into those countries, (2) commence work with IICA and C/LAA to link the LINDA project and the AGROINFO initiative in the Andean region with buy-in from the IADB, (3) field work by the AT to establish additional collaborative arrangements and buy-ins in the Andean region of South America, and (4) continued work to implement the LINDA system in Mexico.

Third year:

(1) Implementation of LINDA system in the Andean region of South America as a joint effort with IICA and C/LAA and the Ministry of Agriculture and Livestock in Ecuador , (2) commence work with IICA and C/LAA to link the LINDA project and the AGROINFO initiative in the other regions of LA with buy-in from the IADB, (3) field work by the AT to establish additional collaborative arrangements and buy-ins in other regions of LA, and (4) continued work to implement LINDA in Central America.

At the end of the third year, LINDA implementation should be complete in Mexico and nearly complete in Central America. Continuation of the project beyond the third year will be needed to complete implementation of LINDA in Central America and the Andean region and to expand LINDA into other regions of Latin America.

Footnotes

[1] Information providers and users are generally the same groups but operating in different roles. For example, while researchers use information in the form of data for research, they also provide information in the form of analysis and policy recommendations. At the same time, government agencies provide information in the form of data but also use information in various forms for analysis and policy decisions. Other information providers and users include livestock producers, input suppliers, processors, marketers, traders, and consumers.

[2] Arrangements with IICA and C/LAA

were to have been finalized in mid-June at the headquarters of IICA in Costa Rica but a request for travel by members of the AT to Costa Rica to make those arrangements was denied by the management entity due to lack of action on the request by USAID.

Collaborating Institutions

United States

Texas Agricultural Marketing Research Center
Texas A&M University
College Station TX, 77843-2124
phone: (409)845-5911
fax: (409) 845-6378

Agricultural and Food Policy Center (AFPC)
Texas A&M University
College Station TX 77843-2124
phone: (409) 845-5913
fax: (409) 845-3140

Texas Veterinary Medical Diagnostic Lab.
Texas A&M University
College Station, TX 77841-3040
phone: (409)845-3414
fax: (409) 845-1794

Texas Agricultural Extension System
Administration Building
College Station, TX 77843-7101
phone: (409)845-7800
fax: (409)845-9542

Oklahoma State University
Department of Agricultural Economics
Stillwater, Oklahoma 70078-0505
phone: (405)744-6082
fax: (405)744-8210

Baylor College of Medicine
Children's Nutrition Research Center
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phone: (713) 798-7000
fax: (713) 798-7171

Global Knowledge Group
7607 Eastmark Dr. Suite 251-B
College Station, TX 77840
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fax: (409)696-2143

Houston Livestock Show and Rodeo
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Houston, TX 77225-0070
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fax: (713) 794-9528

U.S. Department of Agriculture (USDA)
Economic Research Service
Western Hemisphere Branch
phone: (202)219-0667
fax: (202) 219-0642

Danone Company
120 White Plains Road
Tarrytown, New York 10591-5532
phone: (914) 366-2891

Mexico

Government Policy Design and Implemenetation

Secretaría de Agricultura, Ganadería y Desarrollo Rural (SAGAR)
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Colonia Roma Sur
Mexico D.F. C.P. 06760, Mexico
phone: (91-5)584-0632
fax: (91-5) 584-2485

Collaborating Institutions

Mexico Continued

Information Providers

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fax: (52-5) 51-5575

Instituto Nacional de Estadistica, Geografía
e Informática (INEGI)
Coordinación Nacional de Censos
Agropecuarios
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CP 20280 Aguascalientes, Ags., Mexico
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Research Institutions

Universidad Autonoma Chapingo
Centro de Investigaciones Economicas,
Sociales y Tecnologicas de la Agricultura
(CIESTAAM)
Programa de Post-grado
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(Coordinador)
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Recursos Naturales y Pesca (SEMARNAP)
Dirección Genenral de Restauración y
Conservación de Suelos
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C.P. 04100 Mexico D.F., Mexico
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fax: (91-5)658-6059

Agribusiness

Purina, S.A.
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06500, Mexico D.F., Mexico
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fax: (91-5) 533-1655

Other Collaborating Groups

Interamerican Institute for Cooperation on
Agriculture (IICA)
Headquarters, Costa Rica
Apdo. 55220
Coronado, Costa Rica
phone: (506) 229-022
fax: (506) 294-741

Belize Ministry of Agriculture and Fisheries
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Belize City, Belize
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Tumix, Calle B,
El Cangrejo, Panama
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fax: (507) 269-7330

Objective 1: Establishment of an Integrated Electronic Livestock Marketing and Policy Information System in the Americas

Outputs	Impacts	End Users	Actions Required	Team Members	Time to Completion
1. An Internet-based electronic livestock information system (ELIS) in each target LA country	1. Farmers in modern and traditional farms throughout LA making more informed production decisions based on readily available and reliable market information 2. Reduction of market power concentration in LA livestock markets 3. Improved market access and economic conditions for small farm production 4. Increased efficiency of markets in generating prices and quantities 5. Improved dissemination of Government policies, nutrition, health, and market regulations 6. Alternative channel for public/private livestock extension activities	1. Livestock farmers and/or association of farmers in each LA country 2. Government policy agencies in LA 3. Universities and research centers 4. Agribusinesses, processors, and traders throughout LA	1. Selection of main in-country collaborating research institution 2. Identification of key livestock information providers and users 3. Assessment of information needs and sources 3. Assessment of information needs and sources 4. Design and testing of a user-friendly prototype in one country to be expanded and implemented in other LA regions 5. Development of collaborative arrangements with information providers and users 6. Implementation of the ELIS in each country 7. Feedback, evaluation, and redesign of ELIS 8. Set up local funding mechanisms to support the ELIS in each country	Group I of AT	3 years (First year Mexico) (Second year Central America) (Third year Andean Region)
2. Integration of national ELIS in LA in a network with U.S. based information system	1. Expansion of local livestock production and access to international prices, alternative technologies, and trade opportunities 2. Generate conditions for future free trade zone in the Americas by 2005 (Initiative for the Americas) 3. Expand business, export, import and investment partnerships among countries	1. Same as above 2. U.S. agribusinesses in the livestock industry with interests in LA 3. Multinational funding and trade agencies with livestock interests	1. Coordination of appropriate hardware and software in each country hosting a LINDA server 2. Definition of a permanent mechanism to coordinate access, maintenance and technical support to the system 3. Establishment of mechanisms for future funding of operation and expansion of the system	Group I (actions 1 and 2) Group II (action 3)of AT	3 years

Development Relevance: Contribution to increase small farmer access to more efficient markets and better technologies

Objective 2: Design of Livestock Research in the Americas to Fill Identified Gaps in Information Related to Market Conditions, Policy Design, Human Nutrition, Animal Health, and the Environment

Outputs	Impacts	End User	Actions Required	Team Members	Time to Completion
1. A regional livestock research database enabling users to easily access and upload research studies 2. An on-line LA livestock research discussion forum allowing e-mail communication, research exchange, and news groups by specific topic 3. A matrix of needed livestock- related research and potential collaborators by country and topic	1. Strengthen LA livestock research and policy institutions, capable of identifying and solving technical impediments and policy constraints to the industry 2. Increased inter- and intra-regional communication and cooperation among researchers 3. Increased knowledge and access to knowledge about animal production technologies, animal health issues, and animal-based human nutrition 4. Changes in production and processing practices that protect the environment and promote sustainability of production systems 5. Increased income among resource-poor livestock producers 6. Improved nutrition and food safety, especially in disadvantaged households in LA 7. More efficient communication channels to define research topics and receive user feedback	1. Universities and research centers in livestock-related sciences in LA 2. Government policy and regulatory agencies in LA 3. U.S. and multilateral donor agencies with activities in LA 4. U.S. Universities with research interests in LA 5. Public and private extension services in LA	1. Identification of livestock-related research centers and resources in each country in LA 2. Identification of key areas of needed research in animal production, human nutrition, and environmental protection in each LA country 3. Design, implementation, and testing of the database application that better serves the needs and available resources 4. Definition of mechanisms to adjust, access, and support the research database in each country 5. Establishment of funding sources, regional coordination, and maintenance responsibilities 6. Demonstration and dissemination of the database in LA countries	Group II of Assessment Team	3 years

Development Relevance: Increased livestock production in resource-poor areas, improved human nutrition and environmental protection by the LA livestock sector.

Objective 3: Training of LA Livestock Producers, Agribusinesses, Researchers, Policy Makers, and Students in Information Technology and the Use of the ELIS for Decision Making at all Levels in the LA Livestock Sectors

Outputs	**Impacts**	**End User**	**Actions Required**	**Team Members**	**Time to Completion**
1. Training of LINDA trainers in each LA country 2. Training of LINDA users (farmers, processors, agribusiness, researchers and policy officers) in each country 3. Involvement of U.S. students in developing information and technology research in LA.	1. Strengthen LA livestock farmers, processors and research and policy institutions, in their capacity to use expanded information for decision making 2. Dissemination of LINDA use benefits throughout the livestock sector in LA, especially among small farmers 3. Increased knowledge and access to knowledge about animal production technologies, animal health issues, and animal-based human nutrition 4. Improved production and investment decision making among LA livestock farmers 5. U.S. students with improved knowledge of LA livestock technological, and marketing conditions	1. Universities and research centers in livestock-related sciences in LA 2. Government policy and regulatory agencies in LA 3. Individual farmers and farm associations in modern and traditional production sectors of LA 4. Agribusinesses, processors, commercial livestock market representatives	1. Identification of leading livestock-related institutions in LA which could serve as in-country collaborators and potential LINDA training centers 2. Design of short term courses tailored to different computer literacy audiences 3. Establishment of funding sources, regional coordination, and maintenance responsibilities	Group I, Group II, and researchers at collaborating institutions in each country	3 years

Development Relevance: Increased ability of small and disadvantaged livestock farmers to make appropriate, profitable production and marketing decisions

Team Member Name	Affiliation	Role/Discipline	Nationality'/Residence
United States			
Williams, Gary Principal Investigator	Texas Agricultural Market Research Center, Department of Agricultural Economics	Professor and Director, Agricultural market information systmes, NAFTA, trade, policy	USA
Eugster, Konrad	Texas Veterinary Medical Diagnostic Laboratory	Animal disease diagnosis and trade regulations	USA
Granovsky, Nancy	Texas A&M University	Extension systmes in developing countries	USA
Knutson, Ron	Texas A&M University, Department of Agricultural Economics	Food Policy	USA
Lifschitz, Carlos	Baylor College of Medicine, Children's Nutrition Research Center	Children's nutrition, buichemistry	USA
Malaga, Jaime	Texas Agricultural Market Research Center	Agricultural Marketing, Trade, and Development	USA
Marvin, Paul Jr.	Global Knowldege Group	Agricultural Market Database Development	USA
Morck, Timothy	Danone Company, Nutritional and Regulatory Consumer Affairs	Dairy product marketing, nutrition	USA
Peel, Derrel	Oklahoma State University, Department of Agricultural Economics	Extension, Livestock Specialist	USA
Sykes, John E.	Houston Livestock Show and Rodeo	Agruicultural leadership development, animal industry	USA
Ward, Jim Bob	Texas agruicultural Market Research Center, Department of Agruicultural Economics	Assistant Director	USA
Latin America			
Avila, Marcelino	Ministry of Agriculture and Fisheries	Policy, Natural Resource Management	Belize
Roman, Jaime A. Viñas	Instituto Interamericano de Cooperacion Para la Agricultura-IICA	Agricultural education and extension	Costa Rica
Cruz, Manul Gomez	CIESTAAM, Universidad Autonoma de Chapingo	Director	Mexico
Rindermann, Rita Schwentesuis	CIESTAAM, Universidad Autonoma de Chapingo		Mexico
Tribaldos, Santiago	Caura Consultores	Policy and Standard Development	Panama

Land Use and Nutrient Management Decision Making in Latin American Agrosilvopastoral Systems

Principal Investigator: *Robert W. Blake, Department of Animal Science, Cornell University, Ithaca, NY 14853. Tel: 607-255-2858, Fax: 607-255-9829, E-mail: rwb5@cornell.edu.*

Narrative Summary

Three planning workshops, also involving a field component with collaborators in Honduras and Peru, were valuable tools for obtaining consensus about research needs for Latin America as a whole, and for developing logical frameworks for addressing those needs. Use of the planning-by-objective logical framework approach proved extraordinarily valuable in catalyzing communication, camaradarie, community, and convergent viewpoints, and in defining researchable problems. These interactions produced an integrated problem model centrally designed around a core theme of nutrient management in soil, plant, livestock and human components of agrosilvopastoral (ASP) systems. The model also addresses the challenges of integrating these components, and the decision needs of different stakeholders. These considerations helped to foster a decision making framework of pyramidal form. This pyramidal framework comprises policy effects at the base, which percolate through other strata. The main mass of the pyramid includes biophysical components of soil, water and plant nutrient dynamics, animal nutrition management, which are integrated through systems optimization and decision support efforts, and a major component aimed at household and community behaviors. Human nutrition and health — representing the individual scale of impact — lies at the apex of the pyramid. Two kinds of hypotheses were defined for this decision making framework — holistic (linking) and domain (thematic) — to ameliorate linkage barriers and to better inform on critical issues at thematic levels of systems aggregation. The research to be proposed will focus on hypotheses and research questions in each of six thematic areas. Our general research objective is to predict probable responses — biophysical, sociopolitical and economic — across countries and agroecozones with insufficient water supplies or risks at ecosystem margins. Human nutrition is seen both as an outcome and as a crucial input in ASP systems. Practical recommendations and impacts are portended from estimating the inputs, including management, which maximize (or minimize) various ASP system responses on these gradients. Carchi, Ecuador is the keystone research site, where research activities will involve all ASP domains. Other primary sites include La Grama, Condebamba Valley and Pucallpa,

Table 1: Institutional Collaborators, Acronyms (or abbreviation), and Country where Active

Institution	Acronym	Ecuador	Peru	Honduras
International Agriculture Research Center	**IARC**			
• Centro Internacional de la Papa	CIP	x	x	
• Centro Internacional de Agricultura Tropical *(linkage)*	CIAT		x	
• International Center for Research in Agroforestry	ICRAF		x	
• International Food Policy Research Institute *(linkage)*	IFPRI		x	
Regional Consortium (Network)				
• Carchi Consortium	—	x		
• Consorcio para el Desarrollo Sostenible de la Ecoregion Andina	CONDESAN	x	x	
• Inter-American Institute for Cooperation on Agriculture (through RISPAL, Red de Investigacion en Sistemas de Produccion Animal de Latinoamerica)	IICA	x	x	x
Non-governmental Organization	**NGO**			
• Aldea Global *(linkage)*	—			x
• Asociacion para el Dasarrollo Rural de Cajamarca	ASPADERUC		x	
• Centro Internacional de Informacion Sobre Cultivos de Cobertura	CIDICCO			x
• Proyecto de Reconstruccion Rural–La Buena Fe *(linkage)*	PRR			x
University				
• Centro Universitario Regional del Litoral Atlantico *(linkage)*	CURLA			x
• Facultad Latinoamericana de Ciencias Sociales	FLACSO	x		
• Escuela Agrícola Panamericana, El Zamorano	Zamorano			x
• Universidad de Cajamarca (linkage)	UCajamarca		x	
• Universidad Nacional Agraria La Molina	La Molina		x	
• Universidad Central de Venezuela, Maracay(linkage)	UCV	—	—	—
Private sector				
• Industria Cajamarquina de Lácteos (Nestle-owned)	INCALAC		x	

Ucayali Valley in Peru, and the Panamerican Agriculture School, El Zamorano, Honduras.

Problem Model

Nutrient management in farming systems is linked to human nutrition, social, and environmental issues. *The goal is rational land use and better husbandry of the stocks, flows and utilization of nutrients in the food system, which are the key factors underwriting family, community, and environmental well-being.* Besides producing more food in food-deficit regions, development policies and programs must also focus on generating employment opportunities and raising incomes, protecting the environment, and improving education, health, and nutrition. The contemporary mandate for a broader approach to farming systems analysis, as well as the fact that there are often possibilities for synergistic improvements between different systems, highlight the importance of addressing these issues simultaneously and in an integrated, rather than an isolated, fashion.

Model Design and Strategy.

Our integrated problem model involves interdisciplinary, inter-institutional and producer collaboration in all agrosilvopastoral (ASP) system domains to diagnose problems, screen options, design and evaluate technological "best bets", and to adapt, calibrate or develop decision-making tools. The central

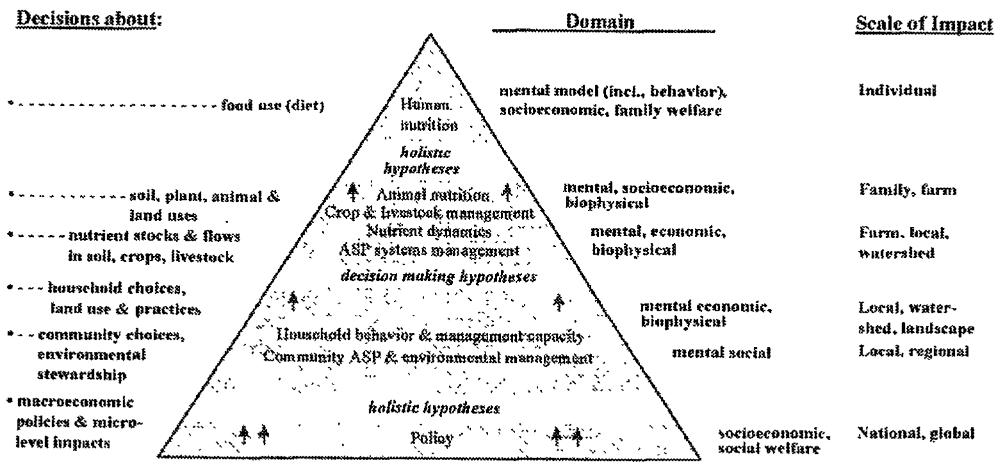


Figure 1. Pyramidal decision making framework for optimally integrating the soil-plant-livestock components of ASP systems to underwrite family, community, and environmental well-being. The master hypothesis is that optimal ASP systems improve land use, food productivity, net economic returns, and human nutrition through efficient cycling and utilization of nutrients. The corresponding research framework comprises hypotheses of two kinds — holistic (linking) and domain (thematic) hypotheses — to ameliorate linkage barriers in the pyramid and to better inform on critical issues at thematic levels of systems aggregation.

objective is to improve food production and farm profits in contrasting ecoregions by systematically and sustainably managing the flows, supplies and utilization of nutrients in various ASP systems. The mixed crop-livestock systems of resource-poor Latin American farmers contain various crops and a livestock resource gradient correlated to household wealth. At the farm level, the decision making challenge is to manage competing demands from the various farm subsystems. These subsystems include: soil health and fertility, water, multipurpose crops (for food and livestock feed), multipurpose trees and forest, shrubs and green manure species, livestock (nutrition of dual-purpose cattle, swine, poultry, small ruminants), and agromedicinal crops and forest products. We denote combinations and permutations of subsystems (e.g., agroforestry, agropastoral, silvopastoral) with the term *agrosilvopastoral.* Thus, ASP management means integrating expected payoffs from nutrient cycling decisions through implementable soil, water, cropping, agroforestry and green manure, and livestock technologies. For example, by determining the baseline nutrient budgets in the dominant ASP systems and by quantifying the land, labor, and organic/inorganic input allocations to livestock and crop subsystems: corresponding yield potentials and net income from these allocations would be important ASP management considerations.

Besides the soil-plant-animal subsystems, numerous other factors influence management and decision making on farms. Better ASP management also means enabling necessary behaviors and attitudes by rural decision makers to find synergies between improved ASP systems, watershed protection, environmental protection, and improved individual and family health and nutrition. Quantifying tradeoffs and potentials for improvement is also needed to assure equity for households and communities. Inconsistent policy signals may reduce the efficiency and sustainability of resource use and restrict welfare gains. Interactions between the farming system, household (community) welfare, family nutrition and health, and the policy environment need better understanding not only for developing countries but also in the US. Therefore, other objectives in our strategy include 1) a participatory analysis of household and community behaviors, particularly regarding natural resource use decision making by ASP households, 2) an economic evaluation of policy effects on households and communities (particularly benefits to women), and scrutinizing sustainability impacts from promising ASP technologies, and 3) an evaluation of diets and health, especially of mothers and children, considering roles for foods of animal origin.

Figure 1 depicts our conceptualized pyramidal decision making framework. The pyramid identifies biophysical, social, and human nutrition ASP system domains, specific kinds of decisions pertaining to each domain (left of the pyramid), and the corresponding scales of impact (on the right). Two kinds of hypotheses are considered: those corresponding to biophysical and sociopolitical and human nutrition domains (or themes), which includes the master biophysical hypothesis in the problem statement, and holistic hypotheses. Holistic hypotheses are not testable in the initial 3-year period of this project; rather they are like assumptions or premises. Nonetheless, they are considered valuable inputs for ameliorating potential linkage barriers and, hopefully, to better achieve goals by avoiding critical errors of omission at thematic levels of ASP systems aggregation. Inferences about holistic hypotheses, and their eventual formulation into testable ones, are expected from the evaluation of domain hypotheses.

Table 2 summarizes the major holistic and domain hypotheses corresponding to the pyramidal decision framework and to the logical frameworks given in Tables 3 and 4, which, are all products of the third planning workshop held at Cornell on May 27-30. Because these domain hypotheses are substantially aggregated, they especially serve as overall goals or guidelines for the specific research proposed in each ASP system theme under the logical frameworks.

Assessment Team Process and Progress

Overview

Tables 5 and 6 summarize a research planning process which was dynamic and which operated smoothly. Three workshops were held as scheduled and involved substantial participation, as tabulated at the end of this report. Figure 2 summarizes the iterative planning process, and Figure 3 informs about various databases from research sites under consideration. Research locations, ecozones, and primary collaborating institutions are shown in table 7. Figure 4 identifies cross-cutting issues among

Table 2: Major holistic (linking) hypotheses and domain (thematic) hypotheses in a pyramidal decision making framework integrating biophysical and sociopolitical and human nutrition components of agrosilvopastoral systems.

Domain hypotheses:						
Master biophysical hypothesis Productivity or profitability in all ASP systems can be increased through more efficient cycling and utilization of nutrients among soils, plants, animals and humans.						
Holistic hypotheses:	**Nutrient Dynamics**	**Animal Nutrition Management**	**Optimization & Decision Support**	**Household & Community Behaviors**	**Human Nutrition**	**Policy**
Master H_o. Development successes are more likely with greater communication & mutual understanding among scientists, producers, & practitioners.	ASP system productivity can be increased by better understanding nutrient cycling mechanisms & with viable nutrient, water, & vegetation management options	Appropriate dietary use of locally produced feeds will increase profitability or productivity of ASP systems.	ASP system productivity & profitability are constrained by the lack of appropriately adapted models and other decision making tools	Enhanced knowledge (traditional & scientific) of biophysical processes can improve farmer decision making & ASP system productivity	Nutritional deficiencies impede how well people process information & make decisions, which can be ameliorated with ASP system choices & management	Sustainable ASP systems must be economically viable at the farm household level and compatible with marketdriven outcomes.
Decision making models. Quantified differences between producers' & scientists' models can help improve ASP productivity, environmental stewardship, & sustainable use of land, water, vegetation & animal resources. **Human nutrition.** Improved ASP decision making will bolster household food security & improve individual nutritional status **Policy.** Diversifying ASP systems helps add biophysical resilience & reduce risk to producers through flexibility in resource reallocations in response to changing economic & political factors.	–The quantities of nutrients which are retained and made available to plants are directly related to the amount of organic matter & soil cover in land management systems –The efficiency of nutrient utilization by plants is synergistic with the supply combinations of organic and inorganic nutrients –Water availability is increased by greater amounts of organic matter and soil (plant) cover	–Improved diets & nutrition management of dual purpose cattle, permitting either increased productivity or profitability, requires appropriate feed composition databases also containing digestion rates for critical nutrient pools –Agroecosystem productivity or net economic returns can be improved with feeding options also for swine, poultry & other animals based on nutrient pool sizes	–A holistic nutrient management decision support system can be built by adapting or calibrating existing crop, livestock, soil, hydrology, land use, biostatistical & optimization models.	–Identification of differences in farmer decision making & scientific models of biophysical processes will reveal gaps in the perspective knowledge systems If a gap identified in one knowledge system is explained in another, the explanations can be combined to develop more productive ASP management practices	Improvements in –child nutritional status will result in time sparing for mothers, –energy & iron status increases work capacity & productivity by adults, –iron & iodine status improves cognitive development & decision making by adults, and –nutritional status reduces days ill in adults	–Increasing intensification of ASP systems on "favored" lands can decrease pressure on less favored lands, permitting complementarity between increased food security & enhanced environmental outcomes –Increased product diversification & the generation of economically viable market alternatives are necessary to enhance the sustainability of ASP systems – Enhancing the sustainability of ASP systems is dependent on addressing critical constraints such as improved infrastructure, land tenure systems, & a more efficient market structure

Land Use and Nutrient Management Decision Making in Latin American Agrosilvopastoral Systems
Better husbandry of system nutrients to sustain family, community, and the environment

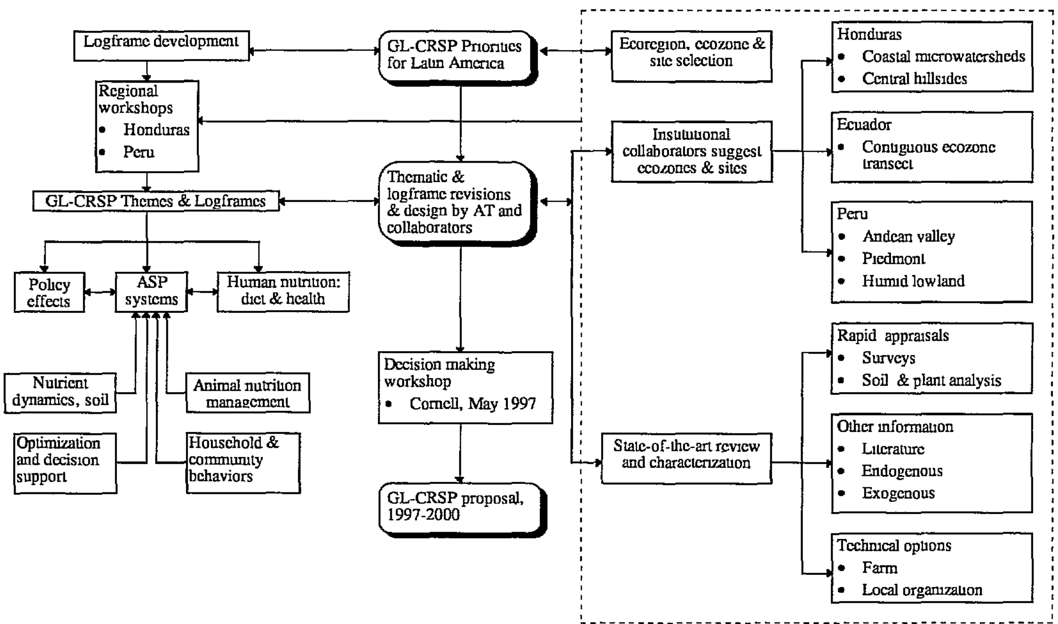


Figure 2: Scheme of the Iterative Plan for GL-CRSP Proposal Development.

Figure 3: Database Structure Comprising Rapid Appraisal, Static, and Dynamica Survey (Monitoring) with Collaborators in Ecuador, Honduras, Peru, and Venezuela.

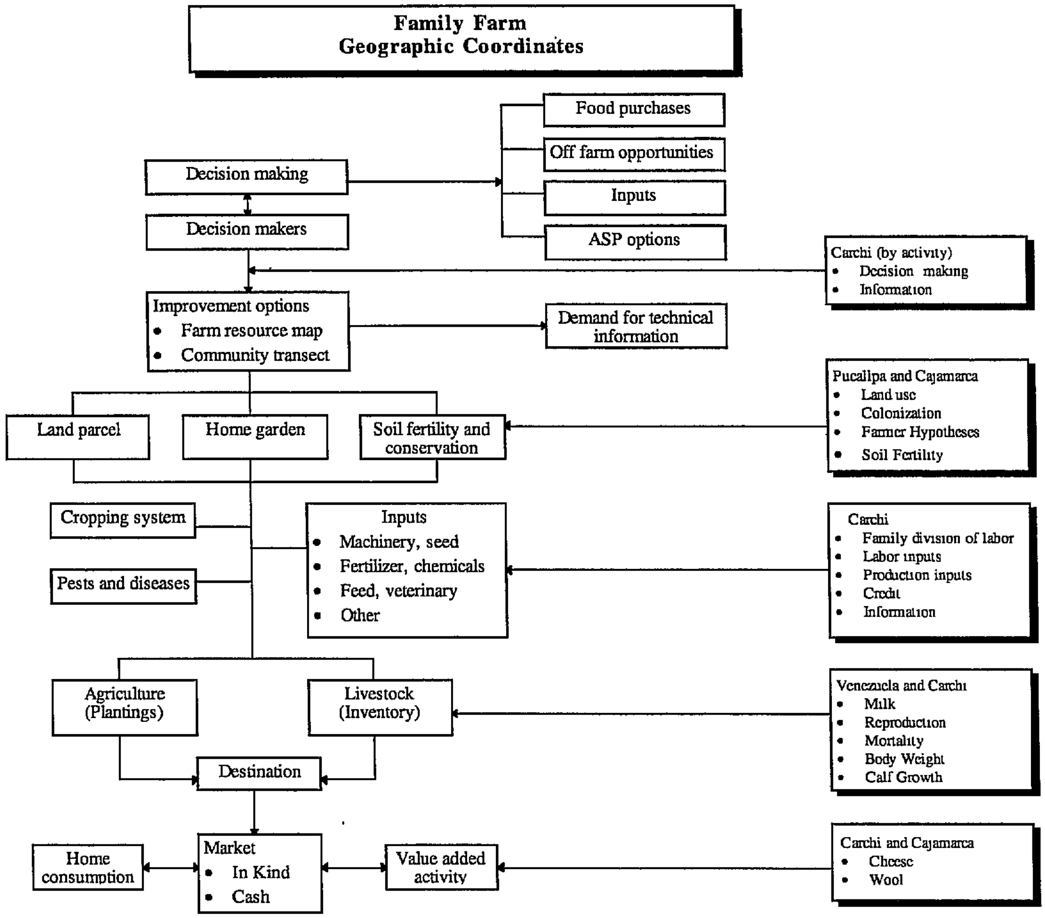
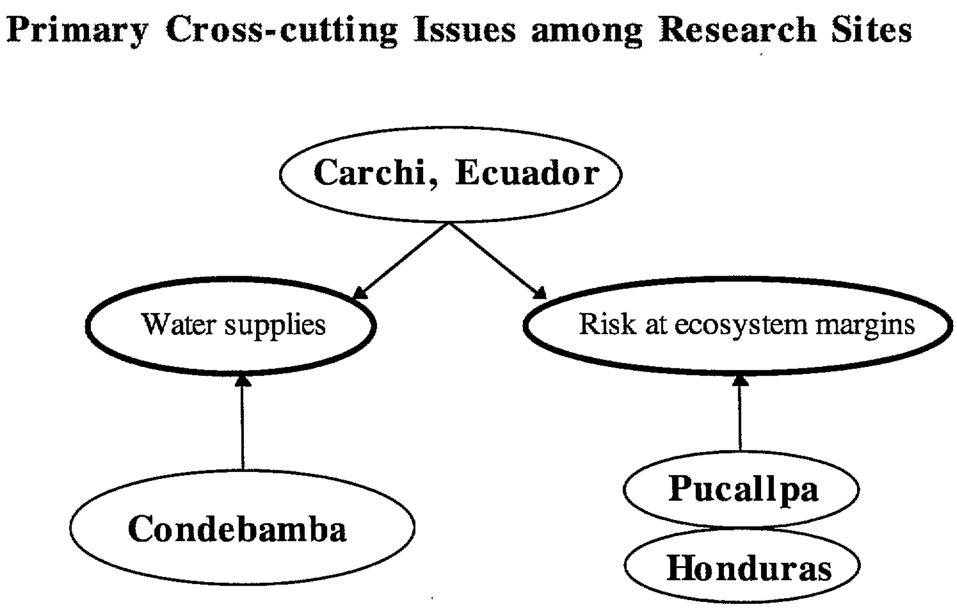


Figure 4: Primary Cross-Cutting Issues at Research Locations in Ecuador, Peru and Honduras.



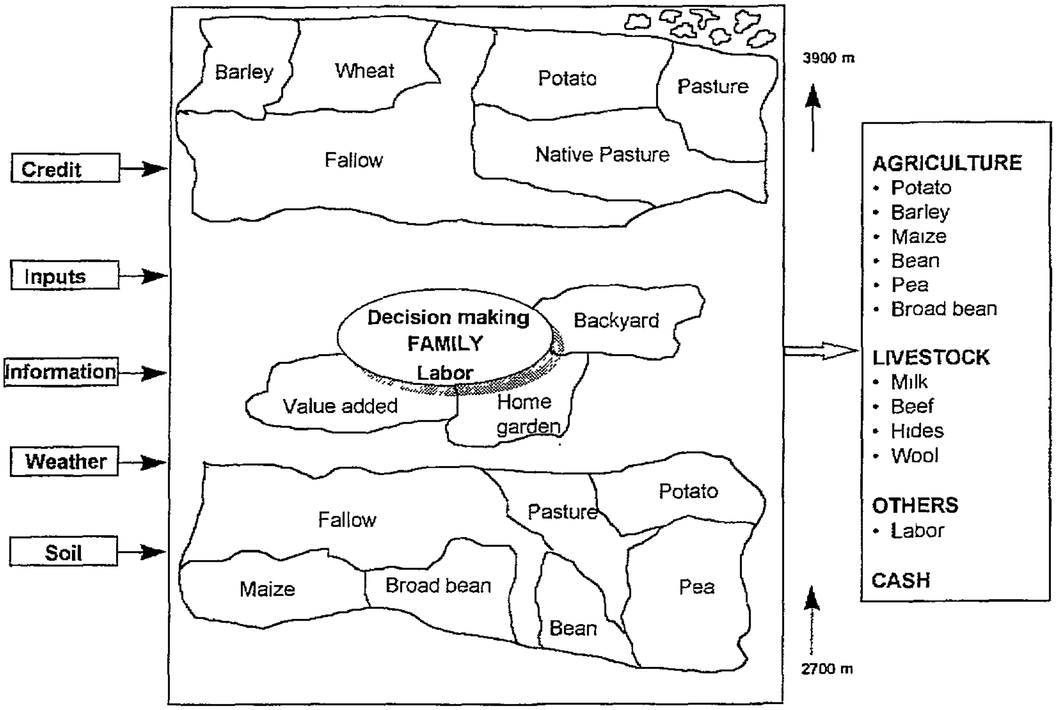


Figure 5: Agropastoral System, Carchi, Ecuador.

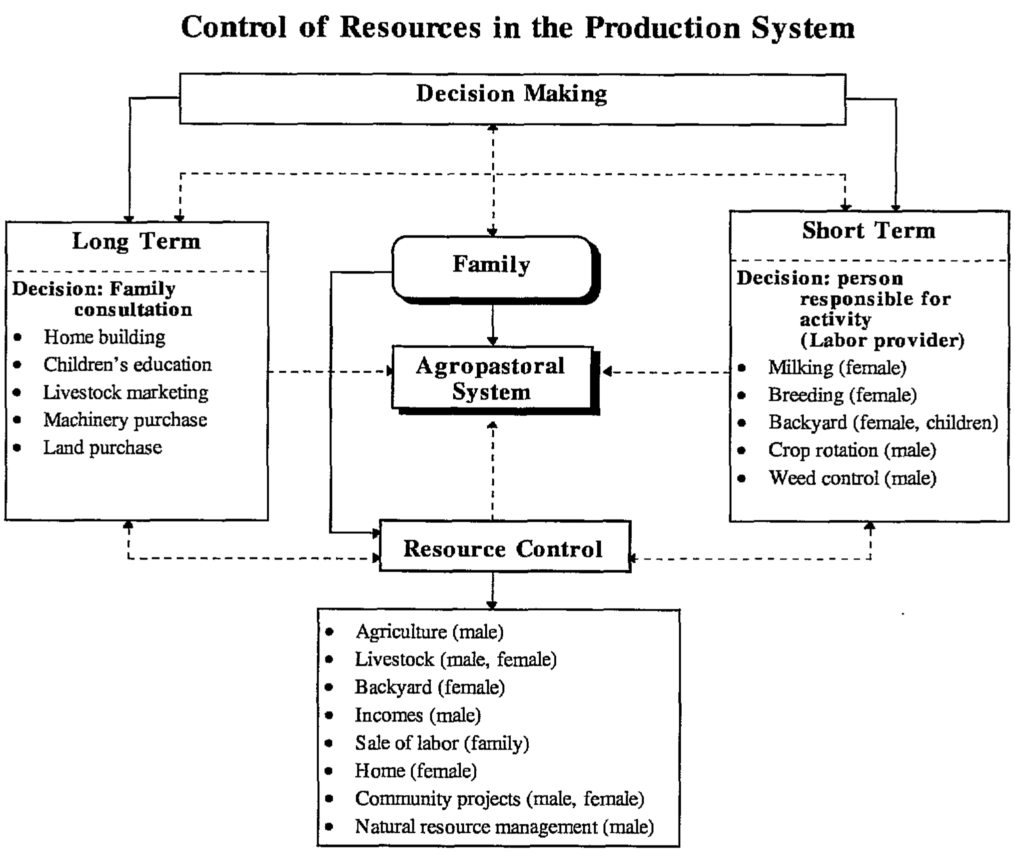


Figure 6: Resource Control and Gender Division of Labor in Carchi, Ecuador.

Table 3: Logical framework of goals, purposes, objectives and activities from the period 1997-2000 for biophysical themes: Land Use and Nutrient Management Decision Making in Latin American Agrosilvopastoral Systems

Nutrient Dynamics	*Animal Nutrition Management*	*Optimization and Decision Support*
Theme Goal Improve and sustain agroecosystem productivity while maintaining or restoring the soil, water, and vegetation resources.	**Theme Goal** Increase agroecosystem productivity through improved animal nutrition, emphasizing local feed resources.	**Theme Goal** Improve the tools for use by decision makers for managing and sustaining ASP and agroecosystem productivity.
Purpose Develop & test nutrient, water, and land management practices that optimize nutrient dynamics among soils, crops, trees and livestock to improve food, cash & energy availability.	**Purpose** Develop practices to supply dietary nutrients for optimal animal productivity.	**Purpose** Develop, adapt, and calibrate decision support systems to evaluate nutrient management in contrasting ASP systems.
Expected Impacts 1 Current and traditional soil, water, and vegetation management practices identified and evaluated to determine "best bets." 2.1 Promising soil, water, and land management alternatives selected & tested with farmer participation against current management of crop-livestock systems. 2.2 Main canal and on-farm irrigation schedules upgraded in accordance with "best bet" practices. 3 Mechanisms quantified for nutrient flows and their interactions with soil, water, & vegetation on farms and watersheds.	**Expected Impacts** 1.1 Existing feeding management alternatives identified & evaluated within the overall farm context. 1.2 Nutrient flows and their dietary interactions quantified. 2 Database created containing key feedstuff variables (e.g, nutrient pool sizes, digestion rates of carbohydrate & protein fractions) for use in the CNCPS model for dual purpose cattle, and for poultry and swine. 3 Animal feeding options selected and assessed with farmer participation.	**Expected Impacts** 1 Existing models evaluated and improved models proposed to describe nutrient flows and crop-livestock performance in ASP systems.

Activities

1.1.1 Review & evaluate secondary information sources to avoid duplication.

1.1.2 Diagnose and characterize current and traditional soil use practices by archiving information from rapid appraisals and surveys.

1.2 *Ex ante* analyisis of information for determining practices, parameters and hypotheses about the biophysical mechanisms and processes of soil, water, and land use (e.g., input-output relationships and models).

2.1.1 Establish trials to evaluate traditional and potentially promising alternatives on farms.

2.1.2 Quantify recycling mechanisms, nutrient flow processes, and their interactions with nutrient sources.

3 Organize field demonstrations, cross visits, and training events coordinated with activities 1.1.2 & 2.1.1.

4 Characterize existing main canal and on farm irrigation schedules.

5 Measure on farm infiltration rates.

Activities

1.1 Characterize yields and availability of local feed resources. Each site.

1.2 Evaluate nutritional value of potentially useful feed resources using current techniques, emphasizing nutrient pools & their unique digestion rates in whole feeds and plant components. Forages & crop residues from each site; leaves/stems from paired sampling when grazing to estimate composition of biomass on offer, Zamorano; sweetpotato, Zamorano; peach palm, Pucallpa, Honduras.

1.3.1 Compile available nutritional information into a CNCPS feed library for dual purpose (DP) cattle.

1.3.2 Predict animal feed requirements & feed budgets for specified productivities.

1.3.3 Identify first-limiting nutrients affecting dry matter intake (DMI).

1.3.4 Validate DMI predictions in DP cattle, Zamorano.

1.4 Develop feeding programs based upon local and introduced resources.

2 Evaluate production and feeding alternatives regarding seasonal availability of energy and protein at the farm level.

3 Promote or conduct training events &/or producer-evaluation workshops, and disseminate information.

Activities

1 Biophysical and socioeconomic databases for ASP systems compiled, analyzed, and made accessible.

2.1 Evaluate potential crop, livestock, soil, hydrology, land use, biostatistical, and optimization models, e.g., DSSAT, EPIC, ALES, FCC, autoregressive milk yield.

2.2 Simplify models, identifying key parameters via sensitivity analysis of existing (secondary) data at various decision maker levels (e.g., locally for nutrient flows & crop-livestock performance; regionally for larger scales).

2.3 Apply crop-livestock optimization & autoregressive milk yield models to local situations & contrasting scenarios. Multiple locations.

3 Collect key primary data based on *ex ante* analyses using existing models. 6-yr goal: better integrate farm level components into bioeconomic decision tools.

4 Promote or conduct training events on use of decision tools to evaluate land, crop & livestock options.

Table 4: Logical framework of goals, purposes, objectives and activities for 1997-2000 for sociopolitical and nutrition themes: Land Use and Nutrient Management Decision Making in Latin American Agorsilvopastoral Systems.

Household & Community Behaviors	*Human Nutrition: Diet and Health*	*Policy Effects for an Enabling Environment*
Purpose	**Purpose**	**Purpose**
Facilitate decision-making processes and enhance management capacities in rural families, communities, and development practitioners to promote sustainable socioeconomic growth.	Develop strategies for improving health and food security through better use of plants, animals and other natural resources.	Enable improved decision making at the local, regional & national levels which provide a range of options to achieve selfdefined goals in the development and management of ASP systems.
Theme Goal	**Theme Goal**	**Theme Goal**
Catalyze multisectorial participation to empower rural families and communities through ASP systems by capitalizing on local values (both tangible and intangible) that are in harmony with the environment.	Assure that more productively managed ASP systems promote improved individual and family health and nutrition.	Analyze impacts and promote awareness of key policies at multiple levels which facilitate ASP systems, are economically viable, socially acceptable and environmentally sound, and which enable policies better corresponding with local needs.
Expected Impacts	**Expected Impacts**	**Expected Impacts**
1 Raised consciousness in households & communities about their own values and potentials. 2 Increased appreciation of local household and community values on the part of researchers, NGO personnel and other development professionals. 3 Greater concensus among stakeholders (i.e., families, communties, NGOs, researchers and other development agencies) about appropriate strategies to meet local household- and community-defined needs. 4 Greater sharing of household and community values, knowledge and experiences in a locally-based teaching-and-learning process. 5 Empowerment of households and communities to be more self-reliant. 6 Improved family and community well-being (e.g., better health, nutrition and income).	1 Food produced for a balanced family diet. 2 Improved access to diverse dietary options. 3 Medicinal and nutritional attributes of regional resources are understood. 4 Greater community food security. 5 Greater individual nutrient security.	1 Enhanced linkages among producers, communities, researchers, management agencies, planners, NGOs, and policy makers. 2 Analysis and evaluation of selected international, national, and local policies at micro- and macro-levels which affect the viability of ASP systems and the welfare of rural households and communities. 3 Case studies evaluated of successful (& unsuccessful) policies which can serve as generalizable models (or models to be avoided) in policy design and improvement throughout Latin America. 4 Improved policies designed for ASP management which respond appropriately to social, economic and environmental needs. 5 Selected new economic opportunities assessed. 6 Training materials developed for various dissemination activities.

Activities	Activities	Activities
1 Bring stakeholders together to agree on research priorities. 2 Characterize households in the research area, including the documentation of traditional systems of knowledge regarding ASP systems, through a collaborative effort involving community members, NGO personnel, researchers and other development professionals. 3 Self-characterization of local perspectives on future development. 4 Evaluate producer & scientific decision models related to the management of ASP systems (i.e., simplified representations that farmers use to interpret social, political, economic, ecological and other observations, generate inferences and solve problems) . 5 Identify producers' decision models which are cultural models of ASP system management (i.e., are shared widely within the community). 6 Identify & implement strategies to address community-defined ASP systems management problems collaboratively with community members, NGOs, researchers & other development professionals. 7 Evaluate the effectiveness of collaboratively implemented strategies, and that allow communities to re-evaluate their needs. 8 Develop training and educational materials.	1 Assess individual and family health and nutritional needs through surveys, community meetings, and review of previous research. 2 Identify nutrient/micronutrient and medicinal sources to increase the diversity of foods and medicines for meeting nutritional & health needs. 3 Evaluate mechanisms for improving health & food security through family gardens and crops, plants and animals in ASP systems, including wild-harvested species. 4 Determine strategies for improving economic status of families & communities by developing marketing opportunities for local crops. 5 Incorporate research information from the systematic measurement of physical motor development into family & community health planning strategies. 6 Develop forums for discussing relationships between nutrition, health and ASP management, and for promoting multiuse plantings in ASP systems. 7 Conduct periodic process & impact evaluations of each proposed intervention and innovation.	1 Bring stakeholders together to identify and agree on priority problems and research related to ASP systems. 2 Develop "case studies" of policy successes and failures relevant to ASP systems which can encourage improved policy design and which are generalizable to other countries and locations. 3 Develop aggregate (macro-level) analyses of policies relevant to ASP systems and households exploiting these systems. Examples include international trade agreements, structural adjustment effects, and price policy. 4 Conduct micro-level policy analyses which identify policy effects on groups disaggregated by type of farming system, gender, community type, household, etc. 5 Develop feasibility studies of new economic options consistent with improved ASP systems. 6 Develop and disseminate information on impacts of selected policies and recommendations for improved policy design. 7 Develop and conduct formal and informal training activities (workshops, courses, short courses, etc.) based on project needs and accomplishments. For example, short courses providing exposure to improved policy analysis methodologies.

Table 5: Major activities since submitting the Global Livestock CRSP Assessment Team proposal.

Activity & Location	Date	Comment
Natural Resources Network (NRN), annual meeting. National Autonomous University of **Yucatán,** Mérida, México	September 1996	Invited paper, "Integrating Livestock and Crops in Small Farms of the Tropics." R. W. Blake, B. Arce, & O. Reynoso.
Review tripartite (Autonomous University Chapingo, Rockefeller Foundation, INIFAP) collaborative NRN research project, Proyecto Sur de Sinaloa, on **green manure cover crops** for dual-purpose cattle systems. Mazatlán, México.	Septembe r 1996	*Mucuna* and *Dolichos* intercropped with sorghum for forage.
Cornell visit by Lucia Vacarro to discuss potential **dual-purpose cattle genetic** research collaboration under the potential GL-CRSP.	October 1996	Central University of Venezuela has a unique dual-purpose cattle data resource.
ASPADERUC, CONDESAN, and CIP conducted a rapid appraisal survey of farms and families, Condebamba Valley, Cajamarca, Perú.	November 1996	Emerged from 7/96 discussions between CIP, CONDESAN, and Cornell on systems research to evaluate sweetpotato's potential as an energy component in mixed farming systems.
Compiled relevant literature by integrated problem model themes for **AT review** & preparation for rapid appraisal and CRSP workshops.	November 1996	Distributed to AT members & other key collaborators.
Zamorano's Esnaola completes swine feeding trial at Zamorano based on *Mucuna* grain.	November 1996	Despite treatment to remove L-dopamine, feed intake was low.
Cornell visit by **Zamorano** Profs. Isidro (Chilo) Matamoros & Marco Esnaola to plan Honduras workshop & to discuss CRSP research priorities, including designing an ASP experimental unit.	November 1996	Seminar given by Prof. Esnaola, "Alternative Feeding Systems for the 21st Century: An Urgent Need for Tropical Countries."
Cornell's E. Fernandes discussed possibility of obtaining **ICRISAT's** pigeon pea germ plasm collection for agroforestry research collaborations.	November 1996	Zamorano is a potential site for maintaining the *Cajanus cajan* resource.
Matamoros requested virus-free sweetpotato germ plasm for establishment at **Zamorano.**	November 1996	Root, forage, and dual-purpose varieties.
Sweetpotato request helped by **CIP's** Carlos León-Velarde who identified 6 promising dual-purpose accessions.	January 1996	Germ plasm shipment expected 5/97.
Rapid appraisals of smallholder farms in 5 locations in different ecozones of **Honduras** as part of a multidisciplinary Cornell course in International Agriculture & Rural Development.	January 1996	See **appendix** for the rapid appraisal data protocol and survey instrument. Survey was an adaptation of the instrument used by ASPADERUC/ CONDESAN/CIP in Condebamba.
Honduras CRSP planning **workshop.**	January 1997	See **appendix** for the workshop agenda.
Peru CRSP planning **workshop.**	February 1997	See **appendix** for the workshop agenda.
IFPRI-sponsored workshop, "Research on Policies for Resource Management on Mesoamerican Hillsides." Zamorano, Honduras.	February 1997	Cornell's David Lee was an invited participant.
Cover crop grain samples received from **CIDICCO** for nutritional evaluation.	February 1997	*Mucuna, Vigna, Dolichos, Canavalia.*
GL-CRSP is **thematic focus** or component in 6 Cornell courses.	January - May 1997	Tropical Livestock Production, Livestock & the Environment, Agriculture in Developing Nations, Special Projects Seminar in Inter-national Agriculture, Action Research, and Veterinary Medicine in Developing Nations.

Table 6: GL-CRSP proposal development and Assessment Team plan.

Activity Sequence	Objective
Initiation	
• Memos outlining CRSP proposal planning process to AT and collaborators.	• Facilitate scheduling and time allocations.
• Plan baseline data collections, samples, initial research, re- source (e.g., germ plasm) acquisition, workshop objectives.	• Launch research; acquire information to encourage relevancy in workshop planning.
Latin American workshops	
• Field visit or rapid farm/watershed appraisal with collabor ators prior to workshop.	• Get acquainted, promote camaraderie, lower barriers, and challenge GL-CRSP research themes, priorities, & model.
• Review GL-CRSP timetable, project terms of reference, and selection criteria for grant awards.	• Clearly state workshop objective.
• Declared that proposal is property of all collaborators for obtaining resources to support individual missions.	• Everyone is a partner.
• Workshop goal: Draft initial logical frameworks of *research priorities for the Latin American region.* Obtain consensus from Central and South American regions. Defer specific 3-yr objectives and proposal budget allocations until the final workshop at Cornell.	• Everyone co-defines the research goals and needs to address crucial problems.
• Workshop participants represent all stakeholders, including farmers and rural organizations.	• Workshop participants have democratic responsibilities transcending their own institution.
• AT members and GL-CRSP collaborators differ by additional responsibilities for AT members.	• There is a level playing field.
• Mid-term report summarizes progress and sets agenda for face-to-face interaction and further planning.	• The planning process is iterative. Everything cannot be accomplished at the outset.
Face-to-face planning & logframe revision	
• *All trip reports* and communications between collaborators are aimed at iteratively reviewing problem themes and the integrated problem model. Written research proposals (and protocols) and revised logical frameworks are expected outputs.	• Goals are best achieved by re-thinking and revising the consensus about needs and best approaches.
• Trip reports and the mid-term report are distributed to all collaborators, leading to next revision and further logframe development and research design.	• All information flows to everyone; everyone's critique is valuable and needed to achieve our goals.
• All materials reviewed 1) in classroom forums by Cornell students and faculty and 2) by consultants asked to recommend relative emphasis on problem themes to obtain an *optimal* integrated problem model.	• Outside viewpoints will be utilized to advise on our thematic and integrated foci, and to help us with difficult decisions (e.g., budgeting) in constituting a final proposal.
• Preliminary recommendations and budget developed for the Cornell workshop, May 28-30.	• Present a specific set of decision making tasks to workshop participants.
Write GL-CRSP proposal, June.	• Present a fully-conceived proposal at the year-

Table 7. Primary research locations, their ecozones, and principal institutions.

Location	Ecozone	Principal Institution
Ecuador		
--Carchi (Rio El Angel).	--Highland (>2700 masl) including the páramo (initially). Contiguous ecozones on a colonized transect down the Mira river to the humid lowlands (future)	Carchi Consortium CONDESAN CIP (Soils Management CRSP) FLACSO The Mountain Institute
Honduras		
--Yeguare Valley	--Central valley & hillsides	CIDICCO Zamorano (experiments)
Linkages with: --Cerro Azul Meámbar park buffer zone (with NSF grant, Pfeffer & Schelhas).	--Central hillsides (~1000m) & protected areas.	Aldea Global
--Las Delicias	--Coastal microwatershed.	CIDICCO CURLA Local organizations Zamorano
Peru		
--La Grama, Condebamba Valley	--Andean valley, 2000 masl	ASPADERUC CIP CONDESAN La Molina
--Pucallpa	--Humid lowland jungle, 150 masl	CIAT ICRAF IFPRI LaMolina NGOs & NGO consortia Public institutions
Venezuela *(linkage)*		
--Various dual purpose systems	--Lowlands	UCV

the primary research sites, where Carchi, Ecuador fulfills a keystone role in linking and catalyzing our interdisciplinary learning efforts. Carchi's agropastoral systems, which impinge on the protected land area of the paramo (high barren plain), are illustrated in figure 5. Associated resource control and gender division of labor issues are sketched in figure 6.

Progress in Developing an Integrated Problem Model.

The team-building and model-building plan in the Assessment Team proposal was fully executed, which permitted garnering inputs, feedbacks, and consensus among collaborators and their institutions. Other collaborators and research sites were identified through this process, which strengthened the model. Consequently, the final problem model reflects the recommendations, constraints, and consensus of the project partners.

The workshops (Honduras in January, Peru in February, Cornell in May) brought institutional players together for sincere exchanges on model development and realistic guidelines for collaborating. Use of the planning-by-objective logical framework approach was extraordinarily valuable in defining researchable problems from a needs assessment. Each Latin American workshop included representation from the other region, and included farm visits, usually with NGO staff, which helped to evaluate research sites. The Cornell workshop focused on developing research hypotheses, and identifying research priorities at each site. Team-building travel (Cornell scientists to Latin America; Cornell visits by Jorge Recharte of the Mountain Institute, Susan Poats of FLACSO, and Steve Vosti of IFPRI) permitted further model refinements. USAID missions were visited in each country. Latin American team members also provided feedback, especially about logical frameworks, from producer and NGO colleagues in their own countries. Numerous feedback, especially aimed at assuring household participation, came from graduate students in multiple Cornell courses where GL-CRSP planning was a principal component. The problem model and research frameworks were reconciled with the approaches and priorities of PROCISUR research institutions. Experienced outside reviewers at the University of California, Berkeley (Louise Fortmann) and the World Bank (Julian Dumanski, Land Quality Indicators Program) also were contacted for consultation.

Future Activities

The goal of this project is to increase the potential of ASP systems to improve human welfare and environmental quality in rural areas of Latin America. ASP systems can improve nutrition, provide income and security, improve farm productivity, improve soil fertility, help maintain adequate flows of clean water, and stabilize farming systems to reduce migration to forested frontiers. The key to all of these outcomes is improving nutrient management in ASP systems and among the individuals in the farm household. These improvements will take place through farm participation and empowerment, technology development, and policy changes.

ASP systems exist within the context of individual health and nutrition status, household and community decision making, and policies and markets. Human health and nutrition is an important outcome of improved ASP systems, but it also feeds back into the system by enhancing the physical and cognitive capacity of farmers to engage in productive activities. Improving the tree component in farming systems through ASP systems has environmental benefits, including improvements in water quantity and quality and nutrient management on farms, as well as direct contributions to the farm economy by providing products for subsistence and sale (food, fuel, fodder). ASP system improvements to the farming system, by fostering economic development and security, can also reduce human migration to forested frontiers and urban areas, with environmental and social benefits. Farm decision making takes place at the household level, where it is influenced by a complex relationship between farmers response to material factors (balancing land, labor and capital to produce food, products, income, security and socio-cultural benefits) and farmer's mental models (including their knowledge of technologies and environmental systems, and the values they place on different components). In both of these areas, there are differences within the household along gender and age lines that have important influences on economic and farming systems, and therefore the adoption of ASP systems. Equally important, households are organized into communities and exist within the spatial context of watersheds and regions; shared mental models and the distribution of material costs and benefits at these levels shape the social and natural systems within which farm and individual decisions take place.

The local processes described above are linked to broader processes taking place at the national and international level. Global economic policy frameworks have recently undergone fundamental changes, including structural adjustment programs, trade liberalization, and privatization. The resulting change in markets and government support for agriculture, combined with simultaneous population growth and internal migration patterns, are having profound effects on intensification, diversification, and sustainability of rural land use. There are also social and biophysical links between regions in different ecozones, defined by altitudinal and other environmental gradients

Our approach will be to develop a closely integrated series of research questions that cut across this system by focusing on the role of economic policies, ASP technologies, and integration of farmer and scientific cognitive models in improving nutrient management in ASP systems, so that human welfare and environmental quality are improved. Research will be conducted within a process that links farmers, NGOs, regional consortia, Latin American universities, and Cornell researchers to assess problems and capabilities, generate knowledge, and recommend and institute changes at all levels.

Problem Statement and Master Hypothesis

The inadequate management of nutrient stocks, flows, and utilization in the soil-plant-livestock-human components of

ASP systems is the major factor undermining the productivity and sustainability of these systems. Better decision making for long term, resilient ASP system productivity is hypothesized to be congruent with a healthy environment and well-maintained natural resources. Consequently, this projects' key hypothesis originates in a biophysical domain, where nutrients recycle between ASP system components. Thus, the projects' *master biophysical hypothesis: productivity or profitability in all ASP systems can be increased through more efficient cycling and utilization of nutrients among soils, plants, animals and humans.*

Collaborating Institutions

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Objective 1-Nutrient Dynamics: Develop & test nutrient, water, and land management practices that optimize nutrient dynamics among soils, crops, trees and livestock to improve food, cash & energy availability.

Outputs	Impacts	End User	Actions Required	Team Members	Time to Completion
1 State-of- the-art geo-referenced database on current crop & livestock systems.	1 Easily available and up to date information on ASP systems, with climate, soils, vegetation, social, and economic data.	Researchers Universities NGOs Private sector Farmers	1. Identify existing databases, evaluate quality, identify knowledge gaps, collect missing and/or current data, compile an integrated database	Fernandes, Blake, Pfeffer, Lee, Gomez, Leon-Velarde, Matamoros, Poats	4 mo
2 Current soil, water, and vegetation management practices identified and evaluated.	2 Indigenous technical knowledge used to help researchers identify positive and negative nutrient management aspects of current cropping systems	Researchers Universities NGOs Private sector Farmers	2.1 Participatory diagnostic surveys of current farming systems. 2.2 Selected sampling of soil, water, vegetation, crops, and nutrient inputs.	Fernandes, Blake, Leon-Velarde, Gomez, Matamoros, Steenhuis	12 mo
3 Promising *(best bet)* soil, water, and land management alternatives selected & tested with farmer participation against current management of crop-livestock systems.	3.1 Active farmer participation in the improvement or development of appropriate nutrient management strategies. 3.2 Better knowledge of the farming systems environment & water management for researchers.	Farmers Researchers Universities NGOs Private sector	3.1 Establish on-farm & selected on-station trials of best bet technologies. 3.2 Evaluate biophysical, social, and economic impacts of ASP strategies. 3.3 Evaluate existing on & off farm water management practices, including irrigation.	Fernandes, Blake, Leon-Velarde, Gomez, Matamoros, Steenhuis	36 mo
4 Mechanisms quantified for nutrient & water flows and their interactions with soil, moisture, & vegetation on farms and watersheds.	4.1 More efficient nutrient & water management and hence increased food production at lower economic and environmental costs in ASP systems. 4.2 Maintaining dry season flow in springs & rivers.	Universities NGOs Private sector Producers	4.1 Intensive sampling of nutrient inputs and outputs in on-farm and on-station trials. 4.2 Establish nutrient budgets for sub-systems. 4.3 Measure water infiltration rates for existing & best bet practices. 4.4 Calibrate existing nutrient decision & hydrology models and develop new models as necessary.	Fernandes, Blake, Leon-Velarde, Gomez, Matamoros, Steenhuis	36 to 60 mo
5 Selected "farmer-endorsed best bet" alternatives provided for testing and evaluation at a regional level.	5 Improved ASP systems implemented at a regional level.		5.1 Formal information-sharing workshops and field days. 5.2 Strengthen existing networks and develop strong linkages among research agencies, NGOs, & farmer organizations to facilitate the exchange of information among stakeholders.	Fernandes, Blake, Pfeffer, Lee, Leon-Velarde, Gomez, Matamoros, Steenhuis	36 to 60 mo

Developmental Relevance: Improve the productivity and sustainability of agrosilvopastoral systems via more efficient nutrient management thereby resulting in better family nutrition, increased net household income, and reduced natural resource degradation.

Objective 2-Animal Nutrition Management: Develop feeding program practices to supply dietary nutrients for optimal animal productivity.

Outputs	Impacts	End User	Actions Required	Team Members	Time to Completion
Annual feed budgets for dual purpose cattle & other livestock in Carchi, Condebamba, Pucallpa.	Feeding alternatives assessed by CNCPS model.	Researchers Universities NGOs Private sector Producers	1.1 Characterize local feed yields & baseline diets of dual purpose cattle and other livestock.	Blake, Gomez, Esnaola, Leon-Velarde, Matamoros, Poats	12 mo
Digestion rate & nutrient pool estimates available.	More accurate CNCPS predictions of animal requirements & DMI.	Researchers Universities NGOs Private sector	1.2 Estimate nutrient pools & digestion rates of carbohydrate & protein fractions in strategic feed samples.	Blake, Gomez, Esnaola, Matamoros	36 mo
Latin American feed library (database) created for nutrition management using CNCPS.	Prediction & calibration of CNCPS enabled at the farm level.	Researchers Universities NGOs Private sector	1.3.1-1.3.4 Compile CNCPS feed library, calibrate CNCPS predictions of animal requirements & DMI, & identify first-limiting nutrients.	Blake, Gomez, Esnaola, Leon-Velarde, Matamoros	36 mo
Recommendations provided for evaluation by producers, NGO & private sector practitioners, & universities.	Feeding management options evaluated with farmer participation.	Researchers Universities NGOs Private sector Producers	2 Evaluate animal production & feeding alternatives at the farm level.	Blake, Gomez, Esnaola, Leon-Velarde, Matamoros	36 mo
Producer-endorsed, *"best bet"* recommendations shared with collaborator network, including other producers & communities.	Producer-endorsed, *"best bet"* feeding options identified.	Universities NGOs Private sector Producers	3 Promote or conduct training events &/or producer-evaluation workshops & disseminate information.	Blake, Gomez, Esnaola, Leon-Velarde, Matamoros	36 mo

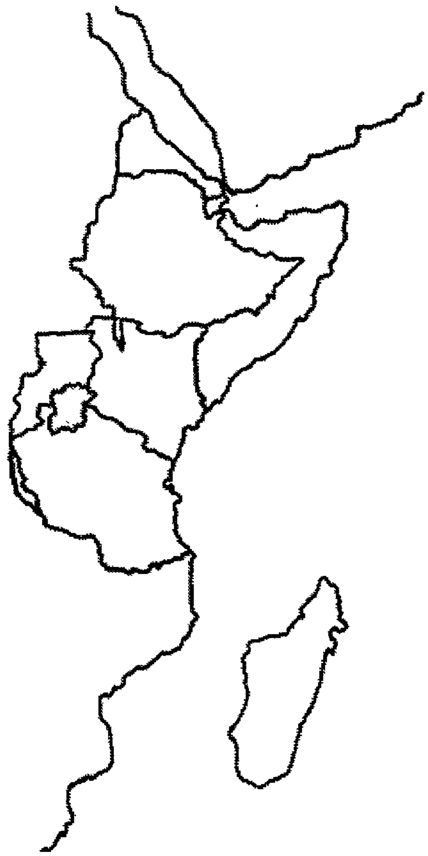
Developmental Relevance: Improve family net income and productivity potentials of Latin American crop-livestock or livestock-based agroecosystems by utilizing and cycling local nutrient stocks through livestock, especially dual purpose cattle.

Objective 3-Household & Community Behaviors: Facilitate improved decision making processes and enhancement in management capacities of rural families, communities, and development practitioners to promote sustainable economic growth.

Outputs	Impacts	End User	Actions Required	Team Members	Time to Completion
Research priorities identified based on stakeholder inputs.	Raised consciousness of farmers about their own values & potentials, & greater consensus among stakeholders (i.e., families, communities, NGOs, researchers, & other development agencies) about strategies to meet locally defined needs.	Communities, NGOs, researchers, development agencies.	Focus groups and stakeholder meetings.	Carchi Consortium CONDESAN FLACSO, ICRAF, Aldea Global, PRR.	Month 1 to 8
Detailed descriptions of local knowledge about specific biophysical processes in ASP systems.	Greater sharing of local knowledge in a locally-based teaching & learning experience.	Farmers, communities, NGOs, researchers, development agencies.	Ethnographies & surveys.	Haas, Parra, Pfeffer, Poats Schelhas.	Month 6 to 18
Identification of emic and etic farmer decision models. (Emic refers to an individuals' own worldview, or decision model; emic refers to an outsiders' view of the individuals' worldview.)	Improved family & community well-being (e.g., better health, nutrition, & income).	Farmers, communities, NGOs, development agencies.	Field trials & other experiments.	Pfeffer, Shelhas, Blake, Fernandes, Steenhuis, Poats.	Month 19 to 30
Collaborative strategies involving community members, NGOs, researchers, & other development professionals to identify & implement solutions to community-defined ASP problems.	Increased capacity for collaborative problem solving.	Farmers Communities NGOs Development agencies.	Strategy workshops	Carchi Consortium CONDESAN ICRAF Aldea Global PRR	Month 30 to 36
Training and education materials on effective ASP management practices.	Empowerment of individuals, households, & communities to be more self-reliant.	Farmers Communities NGOs Development agencies.	Implementation workshops, classroom training, & outreach.	Carchi Consortium CONDESAN ICRAF Aldea Global PRR	Month 30 to 36

Developmental Relevance: Self-reliance and sustainable ASP systems require: 1) the empowerment of local families and communities, capitalizing on local values that are in harmony with the environment, and 2) the development of decision models that lead to technology and policies geared to local needs.

Team Member Name	Affiliation	Role/Discipline	Nationality'/Residence
Blake, Robert Principal Investigator, Professor	Cornell University	Optimization, Animal Science, Animal Breeding	USA
Gómez, Carlos	Universidad Nacional Agraria La Molina	Animal Science, nutrition	Peru
Fernandes, Erick Assistant Professor	Cornell University	Cropping systems, soils	Kenya
Haas, Jere Professor	Cornell University	Maternal-child nutrition, diet	USA
Lee, David Professor	Cornell University	Economic policy	USA
León-Velarde, Carlos	CONDESAN	Systems science	Peru
Matamoros, Isidro	Zamorano	Animal Science	Honduras
Pfeffer, Max Associate Professor	Cornell University	Social science, environmental analysis	USA
Quiroz, Roberto	CIP	Natural resources, systems science	Panama
Ruiz, Manuel	RISPAL/IICA	Institutional network building, policy	Peru
Schelhas, John Research Scientist	Cornell University	Natural resources, community impacts on environment	USA



East Africa

Integrated Modeling and Assessment for Balancing Pastoral Food Security, Wildlife Conservation, and Ecosystem Integrity in East Africa

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Narrative Summary

Pastoralism or extensive livestock herding is the most prevalent form of land use in East Africa in terms of land area utilized. These pastoral regions also support some of the largest and most viable wildlife populations in Africa. Pastoral livestock production has been highly compatible with wildlife conservation in the past, but this compatible interaction is showing signs of disintegration. Wildlife declined markedly during the 1970's-1990's. Although population growth, poaching, and land use change were major causes, much of the decline in Kenya, at least, could be attributed to efforts to commercialize livestock production, create group ranches, and exclude wildlife to minimize livestock-wildlife competition. In widespread areas of East Africa, traditional pastoral grazing lands have been lost to cultivation and wildlife reserves. These losses have reduced pastoral ecosystem integrity, and have probably contributed to wildlife declines outside protected areas. Thus, livestock-wildlife and livestock-environment interactions have been major constraints to both livestock development and wildlife conservation.

We are proposing to develop an integrated modeling and assessment system (IMAS) to assess livestock-wildlife interactions in pastoral ecosystems of East Africa. The assessment system will integrate computer modeling, geographic information systems (GIS), remote sensing, and field studies. The system will enable alternative policy and management strategies to be objectively explored, debated, implemented, and reassessed. Stakeholder involvement will be elicited from the outset. Regional level analyses for East Africa will eventually be conducted using GIS, modeling, networking, and cross-site comparisons. The regional GIS and modeling analyses would be used to identify and prioritize areas of strong and problematic interactions between pastoralists and wildlife.

Our ultimate goal is to improve prospects for increasing food security, conserving wildlife, and sustaining ecosystem integrity throughout the region. Pastoralism and wildlife conservation can be compatible enterprises. The combination of land-uses can be economically beneficial, support the welfare of pastoral people, and also conserve wildlife and the environment.

Compatibility requires careful management and a policy framework which is sensitive to the needs of both pastoralists and wildlife. However, quantitative methodologies for impacts of alternative policy and managment solutions on pastoralists, wildlife, and ecosystems are lacking.

Two workshops were held in East Africa to develop the assessment approach and to identify appropriate sites and establish a communication network. An interdisciplinary team was formed, comprised of U.S. and East African scientists, pastoralists, resource managers, and other stakeholders. Input from the region was obtained through problem statements given by regional representatives, and group identification of scientific priorities, policy and management issues, and potential benefits of the IMAS at individual sites. The overall design and specific components of the integrated modeling and assessment system were developed in working groups. Potential implementation sites were identified representing the wide range of problems encountered in livestock-wildlife interactions throughout East Africa.

Problem Model

Much of Africa is suitable only for livestock production and wildlife conservation. Climatic patterns make cultivation difficult or impossible in the arid and semi-arid regions of East Africa. Droughts occur with high frequency and the East African bimodal rainfall regime is unfavorable for crop production (Pratt and Gwynne 1977, Ellis and Galvin 1994). Consequently, pastoralism or extensive livestock herding is the most prevalent form of land use in East Africa in terms of land area utilized. These pastoral regions also support some of the largest and most viable wildlife populations in Africa. Traditional pastoral livestock production has been highly compatible with wildlife conservation in the past, but this compatible interaction is showing signs of disintegration. Spatial components of pastoral ecosystems have been disrupted by competing forms of land use, with negative implications for ecosystem persistence (Coughenour 1991). Pastoralists who have lived with wildlife for centuries often reap little benefit from the income which wildlife generates through ecotourism (Norton-Griffiths 1995). Although the idea that livestock production and wildlife conservation are compatible is shared by many, and there are examples of successful integration (Western 1982, Cumming 1991), there are examples where compatible associations of pastoralism and wildlife are deteriorating (eg. Arhem 1985, Galvin 1995).

Kenyan rangelands support over 25% of the human population, and over half of the livestock population of that country. The livestock sector produces 10% of the gross domestic product. About 80% of Kenyan large wildlife are found on these areas. Income from associated tourism has grossed over $500 million per year, and has become an important and reliable source of revenue for the national government and local authorities (Ottichilo et al. 1997). According to one source tourism is the primary source of foreign exchange, and wildlife-based tourism is 50% of the total (Byrne et al. no date, Grootenhuis et al. 1991).

Recently released wildlife monitoring data of the Kenya Department of Resource Surveys and Remote Sensing (DRSRS) show that during the 1970's-1990's there were significant declines in 13 wildlife species, while only 4 species showed no significant decline (Ottichilo et al. 1997). The majority of the observed declines occurred during 1970-80. The main causes of the decline were poaching and landuse change, but much of the decline could be attributed to efforts to commercialize livestock production through the creation of group ranches (Ottichilo et al. 1997). Wildlife were systematically excluded from these areas to minimize livestock-wildlife competition. Indeed, there seems to have been little doubt that livestock production would be reduced by wildlife. One study showed that grazing competition may reduce net ranch income by 50% or more (Byrne et al. no date, Grootenhuis 1991). Costs of additional disease control may reduce ranch income by another 15%. Furthermore, wildlife provided no direct benefit to the land holders. Wildlife also declined significantly in areas where the government promoted arable land use in the arid and semi-arid ecoclimatic zones (eg. Narok, Laikipia) (Ottichilo et al. 1997).

Ecologically unsound livestock development schemes, coupled with increased human population densities have often led to overgrazing and environmental degradation (Coughenour 1991). It has been suggested that a common cause of livestock and wildlife declines (Otichello et al. 1997) may be a reduction in rangeland carrying capacity brought about by progressive rangeland degradation (Rainy and Worden 1997). The degradation would presumably be a result of excessive livestock densities and restricted livestock movements. Unfortunately, there are little data to show that range production has declined throughout the region. Livestock declines have probably contributed to the dramatic increase in livestock raiding in northern Kenya in the last two years, however (Rainy and Worden 1997).

Thus, livestock-wildlife and livestock-environment interactions have been major constraints to livestock development in East Africa. The approach of simply attempting to maximize livestock production through ranching, banking, or other schemes, has backfired because of a lack of understanding of livestock-wildlife interactions, failure to assess the direct and indirect effects of livestock development on wildlife and the environment, failure to recognize the ecological adaptive features of traditional pastoralism, and failure to recognize the importance of wildlife for economic development and long-term ecological viability in this region. Livestock development in this region cannot occur without integrated assessments of livestock-wildlife interactions and resultant effects on human welfare. There is clearly a need to establish a more appropriate and sustainable balance between food security and natural resource conservation in the pastoral regions of East Africa.

Landscape-level integrated assessments are essential since that is the scale at which livestock, wildlife and environment interact, and at which land use problems can be solved through community-based conservation, and integrated conservation and development programs. Regional-level integrated assessment are needed for policy formulation at national and international levels. For example, regional conservation strategies are being formulated through methodologies like GAP analyses, i.e. the identification of biodiversity hotspots and their protection status, and the sizes and connectivities of wildlife reserves (Scott et al. 1993); and the identification of large-scale metapopulations, migration corridors, and related opportunities for preserving genetic diversity (Harris 1984, Hansen et al. 1993).

During the first half of our research we revised the problem model as follows.

Patterns of land use in pastoral areas of East Africa are rapidly changing, mainly towards systems of decreasing spatial scale, and reduced options for large-scale livestock movement. In Kenya, there was conversion of former Maasai communal grazing lands into group ranches in the 1960's. Now, these group ranches, and other communal grazing lands in Maasai land and elsewhere are being subdivided and privatized. In many cases land-tenure rights have been granted in small parcels to individual families. They may attempt to use the parcel as a private ranch, or increasingly, they are using the value of the land holding as collateral to take out loans. As spatial scale decreases, intensity of use usually increases. Above a certain livestock density, wildlife apparently cannot exist. A second trend in land use is the increasing adoption of small-scale farming by pastoral people. In some cases the pastoralists are being encouraged to do so. Increasingly, pastoral systems are mixed systems of livestock and small agricultural plots.

Although wildlife dispersal areas have been occupied by pastoralists for many decades, agricultural development in the dispersal areas now threatens to destroy season grazing, and close critical game migration corridors (J. Kinyamario, pers. commun.). The remaining parks and reserves are becoming isolated islands with smaller, less diverse, and genetically poorer wildlife populations. The current government policy in Kenya is to subdivide the large group ranches, but the consequences of this subdivision for wildlife and plant biodiversity are unknown. Pastoralists and wildlife both need to move seasonally, for survival and production. Inappropriate programs to regulate pastoral movements may decrease livestock production and survival. There is actually little capability now, to be able to predict the effects of disrupted movements on the welfare of either the wildlife, or the pastoral livestock.

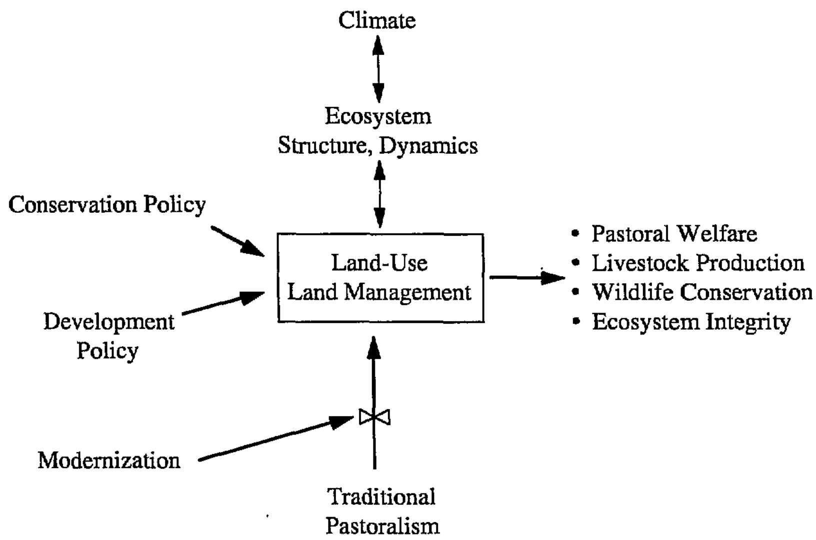
The original problem model emphasized spatially extensive pastoral ecosystems. We broadened the problem model to include a wide range of land tenure arrangements ranging in spatial scale from: (a) private ranches (eg. Kajiado, Kenya, Laikipia), to (b) group ranches (eg. Kajiado, Loita), c) restricted communal land use (eg. Serengeti-Ngrongoro), to (d) traditional communal land use (eg. Loliondo, Turkana), to (e) parks which exclude people entirely.

Many of the formerly wildlife rich pastoral areas of East Africa are now depauperate or wildlife poor, due to warfare and increased access to advanced weaponry. J. Else pointed out that this is especially true in Uganda, and may also be true in Ethiopia, Somalia, Sudan, and Eritrea. For example, game was essentially extirpated from NW Uganda during the Amin and Obote years. Now there is continued rebel activity coming from southern Sudan. In Karamoja, most of the game has been eliminated due to the arming of the people with automatic weapons left behind by Amin's exiled forces. A few "community" game reserves do exist. Game declines in Turkana can also be attributed to access to weapons, and a weak conservation ethic among the people. Other reasons for wildlife decline include increasing human populations, and increased use of marginal lands by agriculturalists rather than by pastoralists.

The original problem model was aimed primarily at wildlife rich areas such as Ngorongoro Conservation Area. The problem model was revised to allow for the fact that in many cases the wildlife-pastoral interaction is more of an issue of rehabilitation, than of conservation. Indeed, according to J. Else, rebuilding the protected area system in Uganda will be a prerequisite to developing tourism in that country. We did not definitively decide to pursue research in wildlife poor areas, however. Security issues are a concern, as are the possibilities for accomplishing anything in such areas in a reasonable amount of time. The integrated modeling and assessment system (IMAS) could be used to provide input and guidance into rehabilitation efforts.

Comments made by a representative of a Maasai NGO (F. ole Ikayo) suggested more attention should be given to assessing the value of indigenous knowledge, both in livestock husbandry and in natural resources conservation. The Maasai have coexisted with wildlife for centuries, and are good stewards of the land. Accordingly, we expanded the problem model to recognize the value of assessing ecosystem responses to indigenous natural resource conservation practices. The Maasai also feel that "capacity building" is not the issue since they already have "capacity". Similarly, "participatory research" is insufficient. What is needed is increased "empowerment". This exemplifies the political problems that lie at the core of land-use conflicts. Pastoralists are losing traditional grazing rights and land to other forms of land use including conservation areas and agriculture. The integrated modeling and assessment system (IMAS) we are aiming to develop will not give political power to pastoralists directly, but instead, the goal is to "empower with information" thereby leveling the playing field of the political arena. We believe that the IMAS will be useful for clearly illustrating the causes and effects of land use changes, according to the goals and objectives of the pastoralists, as well as other land use interests. Lack of information about these causes and effects has led to no-win situations, as competing land users have not been capable of expressing their goals in objective terms, much less coming to a successful resolution. At present there are either no data to support the viewpoints of either side, or the data have not been provided in a useful format.

Figure 1: Problem Model



The problem model can be summarized at this point as shown in Figure 1. Changes in land-use and land management appear to be central to the entire problem. Land-use interacts with ecosystem structure and dynamics through such processes as primary and secondary production, which are in turn driven by climate. Both development and conservation policy influence land-use, with subsequent impacts on the ecosystem, pastoral welfare, livestock production, wildlife conservation efforts, and ecosystem integrity. Although traditional culture influences land-use, land management, modernization and increasing interaction with society at local through regional scales is also affecting land-use, with subsequent impacts on the variables mentioned above.

The problem model evolved further through Workshop II, in which we specifically solicited input from regional representatives of government and non-government organizations.

A common theme expressed by the representatives was that information by itself has little impact, even when it is readily available. For example, the Kenya DRSRS data showing long-term trends in wildlife abundance and distribution has been little used for policy formulation. Only recently has the data been summarized (Ottichilo et al. 1997, Rainy and Worden 1997). A similar comment was made by S. Chama at the first workshop, that information is already abundant, and it has had little impact. In fact, he pointed out there was a moratorium on information gathering in Maasai-land. H. Cheruiyot of KARI also pointed out that there is already lots of information available. The indigenous knowledge of the pastoralists has even been taken into account. The problem now is what to do with the information, especially how to use it for effective policy formulation. For example, there currently are no policies on competition for forage or disease transmission between wildlife and livestock. According to N. Menzies of the Ford Foundation, there is little evidence that information by itself can sway entrenched socio-political and socio-changes in land use (and thus pastoralists and wildlife). We need to do more than just inform management. We need to find solutions that take into account and resolve the wants and needs of stakeholders at different levels. H. Dublin of World Wildlife Fund (WWF) pointed out that despite high quality science, political interests may drive processes in other directions, thus constraining the effectiveness of purely science-based analyses. There is a need to understand how policies originate, and what their effects are. There is a need to improve the use of available information for policy formulation. Policy assessments are imperative.

This might be summarized by making the important distinction between simply providing information, and making the information useful. Information is only useful if it is transformed into knowledge which explain the causes of the observations or when it can be used to develop potential solutions. Many of the causes of change are external to the local ecological and social systems. Consequently, despite excellent information about local ecological and social systems, the information may have little impact. In a sense, local ecosystems have become decoupled from processes at broader scales. As a result, assessments must do a better job of integrating local and regional scale processes. Strictly local-level assessments cannot succeed. Conversely, the broad-brush approaches that have been taken at only the regional levels have not been effective in producing tangible results and there is a critical need for solutions which produce tangible results at the local level (H. Dublin).

For information to be useful, it must inform people about the implications of changes, and show linkages between cause and effect. There is ample information and widespread recognition that changes are occurring. What people need is information about the trade-offs of taking alternative courses of action. Why have the observed changes occurred? What can be done? People need to be able to make informed choices about alternate land-use strategies to select the one that is most viable (N. Menzies). This is exactly what our proposed integrated modeling and assessment system aims to accomplish. We will not simply provide information about change, we will provide both retrospective and prognostic information about the causes and implications of change under alternative scenarios of policy and management. We will develop a tool which integrates and synthesizes information from different sources and disciplines. The integrated modeling and assessment system (IMAS) will be used to evaluate alternative solutions, and search for the best solution. It will involve stakeholders and scientists in an integrative assessment process, which is markedly different from developing data sets that will be archived in obscure documents or computer files.

The original problem model emphasized the potential conflicts encountered when wildlife and pastoralists share the same habitat. However, E. Barrow of American Wildlife Federation (AWF) suggested that wildlife conservation and pastoralism are potentially complementary land uses. Pastoralists and wildlife have similar requirements for large ranges, opportunistic movements, water sources, dry season grazing areas, and diversity of browsers and grazers. They also have several common enemies including land and water peremption by cultivation and irrigation, lack of rights to access land, and lack of economic returns from wildlife conservation. Pastoralists and wildlife have three main conflicts: competition for resources, disease, and damage. However, the benefits arising from compatibilities of the two land uses are likely to offset the costs of conflicts if ways can be found to accrue benefits from conservation. Pastoralism has considerable economic value which has not been factored into integrated assessments thus far. In contrast to the previous emphasis on conflicts between wildlife and pastoralists, the combination of pastoralism and wildlife may prove to be an economically successful land use, from both a local and national perspective. We caution, however, that the ecological characteristics of intact pastoral ecosystems, such as ability to move over large areas and access key seasonal grazing areas, would have to be fully recognized, and either conserved or emulated for successful combined use. Pastoralism was indeed a sustainable land use under free access to grazing lands, but the reality is that now, land use is constrained. Having recognized that fact, we propose that these constraints can be alleviated through strategic management and policy. Our integrated modeling and assessment system is aimed at the identification of these effective strategies.

Progress is being made in Kenya towards solving the problems of conflicts between wildlife and other forms of land use, including pastoralism. A new national wildlife policy (1996) has been put into place. The policy calls for developing partnerships among government agencies, local authorities, and private landowners, and an integrated approach to conservation and development based on coordinated ventures and interagency coordination (Ottichilo et al. 1997). In implementing the policy, Kenya Wildlife Service (KWS) has created the Partnership Department whose main objective is to encourage land owners to accept wildlife on their land and by assisting land owners to obtain tangible benefits from wildlife, including benefit sharing, tourism, and certain forms of utilization (Ottichilo et al. 1997). Where the program has been implemented, land owners are eager to keep wildlife on their land. Ranchers in Laikipia and Nakuru are now conserving wildlife on their lands.

If the solution to wildlife-livestock conflicts is being implemented already through such policies, then how useful will the proposed integrated modeling and assessment system (IMAS) be? Firstly, these schemes have not been widely implemented throughout East Africa. They have been implemented only in the more modernized districts of Kenya, which is the most highly developed and privatized country in the region. Secondly, the schemes have not been implemented long enough, or over a large enough area, to demonstrate that they are universally successful. Thirdly, the IMAS will be designed so that it can and will be used to conduct assessments of areas where these schemes are implemented, such as Kajiado and Laikipia. The system will be useful for monitoring and assessing the success of the schemes, for identifying why they do

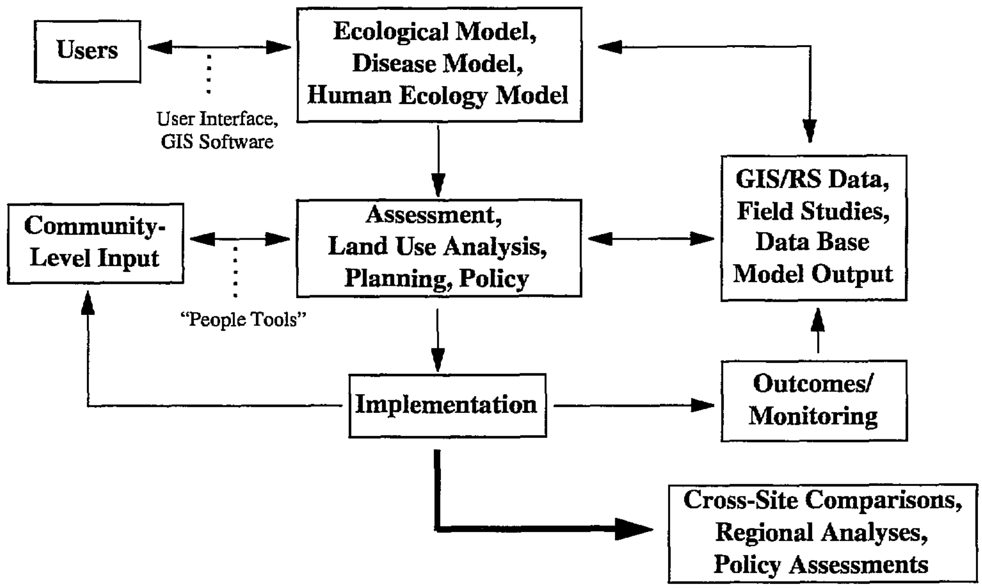


Figure 2: Integrated Modeling and Assessment System for Livestock-Wildlife Interactions in East AFrica.

or do not work under the existing constraints, and for providing useful information to managers to further refine management strategies and policies. Livestock production and wildlife conservation could be even more highly optimized through the use of the proposed IMAS in such environments.

Assessment Team Process and Progress

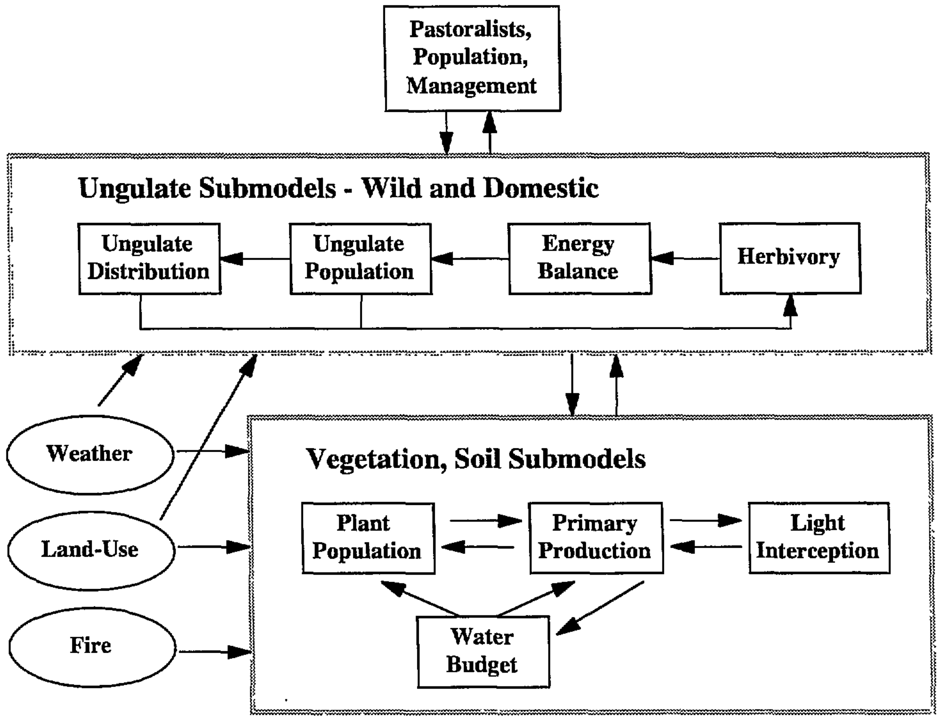
Overview of Proposed Activities

Our ultimate goal is to improve prospects for increasing food security, conserving wildlife, and sustaining ecosystem integrity. We share the conviction that pastoralism and wildlife conservation can be compatible enterprises. The combination of land-uses can be economically beneficial, support the welfare of pastoral people, and also conserve wildlife and the environment.

The objective of our assessment team process was to develop a protocol which combines integrated modeling, geographic information systems (GIS), remote sensing (RS) technologies, field methods for assessing wildlife, natural resources, pastoral land use, nutrition, and household economics (Figure 2). The proposed approach would start with the SAVANNA model, a GIS-based ecological simulation model originally developed for the Turkana pastoral ecosystem in northern Kenya (Coughenour 1991,1992,1993, Ellis et al. 1993). This model builds upon concepts and methods used to assess energy flow through a spatially extensive pastoral ecosystem (Coughenour et al. 1985). The spatially explicit model simulates plant growth, animal foraging, animal production, animal population or herd dynamics, and animal spatial distributions (Figure 3).

During the initial one-year assessment we aimed to create an interdisciplinary team of U.S. and East African scientists, managers and other stakeholders which would develop an analytical system through which alternative policy and

Figure 3: Savanna Model Structure.



management strategies can be objectively explored and debated . The Assessment Team, with American and East African members, would assess and modify the integrated modeling and assessment system (IMAS) to fit selected regions in Tanzania, Kenya, Uganda, and Ethiopia. The Assessment Team (AT) research would focus on a review of the SAVANNA system, its potential application, data requirements, and necessary modifications to be useful as an integrative management tool.

In our Assessment Tèam research we proposed to identify and focus on study sites where there has been a long history of research, with involvement and familiarity by AT members. We suggested the Ngorongoro Conservation Area (NCA)/Loliondo Game Reserve/ Serengeti National Park Region as a primary intensive study area for the development of the IMAS.

The approach for selecting team members would be to make contacts in writing, fax, or email, invite representatives to the workshops, or arrange to meet prior to or after the workshops at their sites. The team members would be selected on the basis of their level of interest and commitment to collaborative research, and the needs of the assessment process.

The assessment team would, through two workshops in East Africa, further design the research agenda, design the IMAS and decide how to provide analysis and assessment procedures for policy and land use analysis for optimizing human welfare and biodiversity in ecosystems which support wildlife, livestock, and biotic diversity.

The workshops would focus on problem assessment, and identifying how team members would work together to contribute to the problem model development and implementation. The current assessment implementation model would be presented, along with a review of the SAVANNA-GIS model and its inputs, outputs, and proposed means of implementation. The model discussions would serve to integrate and codify various components of the overall assessment. The IMAS would evolve through each workshop. The problem analysis would include identification of critical information needs, how component studies would fit into the broader IMAS, methods of transferring information among collaborators, and methods of building capacity through education, outreach and stakeholder participation. Feedback from other team members, and from invited African stakeholders and collaborators would be elicited throughout the workshops.

The assessment team formation process would produce several results. By the end of the process we anticipated that the problem model and the IMAS would have received considerable thought and input from stakeholders. The IMAS would have evolved to a stage where it could be conceptually implemented at selected study sites.

Progress and Possible Future Activities

Model Framework

The conceptual framework for the IMAS evolved considerably during the assessment process. The principle objective of the IMAS is to inform stakeholders of the consequences of their activities. It should guide decision making with accurate and reliable information on interactions between livestock and wildlife. To accomplish this, the model must quantify the costs and benefits of alternative management scenarios to each stakeholder. The IMAS should identify areas of misunderstanding, and empower stakeholders with information. A user interface between the model and stakeholders must be developed, scenarios of each of the stakeholder's preferred actions would be simulated, and alternatives could then be provided for stakeholders to meet their needs and resolve their conflicts.

The IMAS will be comprised of a process of empirical and data-based assessment procedures, linked to computer-based procedures, and landuse planning and analyses. Research will be conducted both within the scope of our project, and by other parallel projects funded externally. Assessments will be made based upon modeling, and participatory involvement from stakeholders at the community level. The results of the assessment would be used in an implementation by the end users such as land managers, and policy analysts. The results of the implementation would be then evaluated at the community level, and the assessment would be modified accordingly. Inventory and monitoring studies will be vital to the IMAS, both as information inputs, and as measurements of results.

The interaction between stakeholders and the IMAS will inform stakeholders of impact scenarios consistent with their goals and objectives. Scenarios will be created and encoded as both spatial and aspatial data that can be evaluated by the IMAS, model, or other analyses tools. The scenarios will be played out in the IMAS and the results returned to the stakeholders. Multiple scenarios can be compared and evaluated relative to different objectives.

The IMAS will be used in an iterative process of conflict resolution and risk analysis, the goal of which is to converge on a solution that all stakeholders can accept. The IMAS will be used to show the conflicts, risks, costs, and benefits to each stakeholder of multiple versions of their proposed solutions. The solutions would then be revised with the aim of converging on a solution that is most acceptable to all stakeholders.

The benefits of the proposed IMAS for each of the seven potential study sites were evaluated by regional participants at Workshop II. For all seven of the sites, it was agreed that the IMAS would be beneficial by:

- improving the policy making process by serving as a focal point for problem evaluation and expanding the range of choices
- providing a capability to predict responses to drought and disease, and
- helping to distinguish effective short and long-term management strategies.

At six of the sites it would be beneficial to:

- suggest best spatial-temporal animal movement patterns to minimize disease risk, and
- putting pastoralists on an equal footing with policy makers.

At four sites, the IMAS would:

- be useful to a land planning agency, and
- assist individual land managers to evaluate alternative land management strategies.

Ecology

A range ecology working group (Workshop I) decided that its primary goals would be to:

- develop a response data base for management practices,
- use the IMAS model to predict and evaluate impacts of drought,
- develop a process for determining forage balance,
- facilitate agreement for range site descriptions,
- develop a monitoring system and,
- determine desired future condition for each site.

Outputs of the range ecology submodel would include maps of resources, resource utilization, resource users, nutrient concentrations, and vegetation change. Additionally, the model would provide diagnostic and prognostic output on progress toward future change.

Biodiversity assessments were also recommended. The goal is to provide increased monitoring capabilities for plant and animal species in relationship to site factors and levels of livestock and wildlife utilization. This would require field work, data analysis, and synthesis.

The range ecology and wildlife working group of Workshop II also identified the following desirable outputs:

- maintain a viable ecosystem,
- maintain a balance between

browsers, grazers and predators,
- reduce the probability and extent of disease transmission, and
- predict land use change and its impact on wildlife and livestock distribution and movements, and therefore numbers and composition.

The model would need to consider distribution, composition and abundance of plants, animals, and human land use, and how these respond to rainfall, ground water, soil, and climate change.

Disease

Wildlife and livestock utilize the same pastures and migrate extensively based on the availability of feed resources, breeding patterns and market forces. Co-existence of wildlife and livestock populations provide conditions that are favorable for transmission of infectious agents from some species of wildlife to cattle, sheep, goats and camels. Some species of wildlife, such as the wildebeest and the African buffalo, can remain unapparently infected with viruses and protozoa and are reservoirs of disease agents that cause diseases with high morbidity and mortality in cattle. The major diseases of wildlife that constrain livestock productivity in the areas adjacent to the designated game parks and reserves include wildebeest-derived malignant catarrhal fever, corridor disease (theileriosis), trypanosomosis, foot-and-mouth disease and rinderpest. Though rinderpest is principally maintained in cattle, epidemics with high mortality have been observed to occur in different species of wildlife. The interactions of livestock and wildlife responsible for cycles of rinderpest outbreak need to be assessed.

The preliminary components of a disease submodel and assessment system were identified. The model would represent factors affecting disease prevalence, including presence of the agent, host resistance, animal movement, and transmission. Weather would influence each of these three factors, either directly or indirectly. Social-cultural policy affects host resistance via control measures, and animal movement. A participatory rapid appraisal (PRA) would be conducted in the selected areas to assess the community perceptions of wildlife as a source of diseases to livestock and also to prioritize the importance of such diseases. Existing data on wildlife associated diseases of cattle would be collated (from PRA, published data, KWS and from veterinary services) and determination would be made of the applicability of such data to develop the output. Epidemiological studies would be conducted to determine important disease-host-vector dynamics within the wildlife and livestock populations.

Human Ecology and Economics

It was clear throughout the assessment process that a human ecology and economics component needs to be developed, which would provide indicators of human welfare at the individual (household), and community levels. These indicators would be measured in energetic and monetary units. Individual-level variables would include income, food energy, population density, and proximity of human settlements. Household and community-level economics submodels should be developed to link to the other components of the IMAS.

Gender issues must be addressed explicitly in these studies. For example, studies would be conducted of gender-related benefits from household cash production from gardens, livestock, hunting, and backflow of tourist revenues.

Human welfare and livestock production have been identified as two of four major objective functions for the IMAS. Both of these relate to the more global objective of using the IMAS to increase food security, as opposed to food production. Food security might be defined as the ability of households to access a reliable and adequate quantity and quality of food, produced by themselves or obtained from markets or social support systems. Indicators of food security include household income, market access, access to land, water, and grazing resources, access to services (health, education, infrastructure), and health and nutritional status. The latter would be monitored through measurements of demography, disease incidence, and energy and nutrient consumption rates.

Sites

It was decided that the IMAS will be applied to a select few (3-5) intensive study sites during the first phase of the project. Potential sites were suggested at Workshop I. A list of site selection criteria was generated, to be used for ranking. The criteria included: presence of pastoralists; wildlife populations; conservation value; representativeness of larger areas; contrasting treatments, environments, policies; data availability; potential for partnerships; likelihood of success, impacts; financial and time constraints; and others. The top sites (in no particular order) included Laikipia District (Uaso Ngiro River Basin, Kenya), the Greater Serengeti Ecosystem (Tanzania), Kajiado District (Kenya), Karamoja District (Uganda), Turkana District (Kenya), Tsavo N.P. - Mkomazi N.P. (Kenya-Tanzania), Lake Mburo N.P. (Uganda), and Tarangiri N.P. -Simanjiro Plains (Tanzania). Regional inputs on scientific priorities, policy and management issues, IMAS benefits, and human welfare and development for each site were obtained at Workshop II.

A study design was identified, in which sites would be selected from across the range of land use intensity and spatial scale - from no livestock use, to spatially extensive pastoralism, to group ranches, and to finally small private land holdings. Site selection will depend upon demand for the proposed IMAS by end users.

Based upon positive support received from local representatives, three sites were chosen as our initial intensive study sites. All three of the sites have good data bases and high likelihood of successful IMAS implementation. It was decided that the Ngorongoro Conservation Area portion of the Greater Serengeti would constitute the best site at the more traditional end of the spectrum. Kajiado would contain a range of situations from large group ranches to small holdings. Lake Mburo would be a good example of a developing ranching and dairying scheme adjacent to a national park. Other sites of high promise include Laikipia (Kenya), Tarangire (Tanzania), Loliondo (Tanzania), Karamoja-Turkana (Uganda-Kenya), Awash (Ethiopia), and Katavi-Rukwa Valley (Tanzania).

Selection among these sites will require further problem analysis, and indications of demand from the potential end users.

The Greater Serengeti Ecosystem (GSE) is a large region comprised of Serengeti National Park, Ngorongoro Conservation Area (NCA), Loliondo and Maswa Game Reserves, and Maasai Mara National Park (Kenya). Serengeti National Park and Masai Mara are parks with a vast wildlife population, well known for the migratory wildebeest herds. Land use pressures in the Serengeti Regional Ecosystem of Tanzania are growing rapidly (Mbano et al. 1995). Pastoralists in the NCA share grazing areas with Serengeti migratory wildebeest and zebra. Pastoral population densities in the NCA nearly tripled between 1966 and 1988 (Perkin 1995). Many have settled, and are cultivating small plots. In the adjacent Maswa Game Reserve, increases in agro-pastoral populations have led to increased poaching, unplanned fires, and illegal tree-cutting (Campbell and Hofer 1995, Mbano et al. 1995). There is increasing conversion of pastoral rangelands to large-scale cultivation, because the economic incentives of leasing out to farmers exceed those accruing from conservation (Norton-Griffiths 1995). Since 1987 when the Tanzania-Kenya border reopened, tourist numbers have increased nearly three-fold and many new lodges and camps have been built (Sinclair 1995). Vehicular traffic has increased markedly (Perkin 1995, NCAA 1995).

Kajiado District, Kenya is the site of one of the great experiments in international livestock development. In the late 1960s, the Government of Kenya requested, and the World Bank implemented the Kenya Livestock Development Program (KLDP), a district-wide project aimed at promoting commercial livestock production among the Maasai herders of Kajiado. The principal instrument was land adjudication; providing freehold title to groups of Maasai who organized themselves into group ranches. The most prominent effect of group ranch formation, reduction of the spatial scale of grazing land exploitation. Though group ranch formation has achieved some of the original program objectives, the unanticipated impacts in Kajiado probably outweigh those envisioned by the KLDP planners. On the positive side, livestock production has increased somewhat over the past 30 years, but not as much as anticipated. Likewise, range degradation is thought to be limited in scope and patchy, while wildlife abundance has not plummeted as has occurred in much of Kenya. On the negative side, cattle/ human ratios have gone from about 14/person in the early 60s to about 3/person in the late 1980s. This is mainly a result of human population growth while livestock numbers have fluctuated or expanded rather slowly. Recent government policies are encouraging subdivision and privatization of the group ranches.

Lake Mburo, located in southwest Uganda, is a National Park adjoining group ranches. It is biologically diverse and wildlife are common. Originally, pastoralists and wildlife inhabited the area in and around Lake Mburo National Park. During the Colonial Era, controlled hunting was instituted. During the 1960s, the area was designated as a game reserve, and a livestock improvement program and ranching scheme were introduced in the surrounding areas. In 1983, the area was designated as a National Park, and the pastoral inhabitants were removed from the land, to be "resettled" on the adjacent ranches. There has been a steady decline in wildlife numbers, especially in the areas immediately outside the National Park since the 1980s. This has been attributed largely to hunting (and poaching) and loss of habitat. Given the Park boundaries, problems have been created with regard to access to land and importantly, access to water for both people and livestock has become limited. The movement of wildlife from the Park to ranch areas has caused problems. There is an issue of disease transmission between humans, livestock, and wildlife, specifically foot and mouth, brucellosis, tuberculosis, and tick borne diseases. Finally, there is pasture degradation due to overstocking of livestock and a lack of mobility inducing overgrazing.

Training, Communication, Information

Training will be essential to the success of this program. At least three American students should receive graduate training, providing increased assessment capacity both during this project, and after it ends. East African students and technicians will also be trained. The goal would be to develop regional capacity to implement the IMAS after the project ends.

We envision a core level of technicians and scientists operating the Decision Support System (DSS) at universities and government agencies, as well as within our project. These experts would train technicians to run lower level analyses on the IMAS at field offices, national park offices, and NGOs. Results would be communicated to pastoralists and landowners through workshops, seminars, and community information centers.

Abstracts and Workshops

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Objective 1: Develop a computerized decision-support system that will improve prospects for balancing the needs of pastoralists and wildlife conservation in East Africa.

Outputs	Impacts	End Users	Actions Required	Team Members	Time to Completion	Developmental Relevance
Ecosystem model which can be readily implemented at sites and regions in East Africa. User interface for model, GIS data, and remote sensing data - specifically designed to assess livestock-wildlife interactions in East African pastoral ecosystems.	Increased ability to quantify ecological constraints on pastoralists and ecological interactions between livestock and wildlife. Development processes which reduce negative livestock-wildlife interactions. Reduced negative interactions between livestock and wildlife.	Government agencies, NGOs, Development specialists, Researchers,	Software design, Model revision and expansion, Programming, Model testing, Model validation, Model application, Training	M. Coughenour J. Ellis D. Child R. Kruska R. Reid L. Rittenhouse Research-Associates Graduate Students	5 years	Development can be conducted with increased capabilities to predict ecological components of livestock-wildlife interactions throughout region.
Development and validation of disease submodel and disease database.	Expanded livestock production and wildlife conservation through cohabitation on same range. Economic benefit for pastoralists.	Pastoralists, Landowners, Tourists, Government agencies, and planners	Define eco-climatic features. Characterize animal populations. Morbidity and mortality surveys by cause. Serological surveys. Computer modeling, Data analysis and interpretation	J. DeMartini P. Rwambo J. Grootenhuis Graduate Students	3 years	Wildlife conservation on rangelands in East Africa. Increased livestock production. Improved human welfare.

Objective 1 continued

Household and community-level economics models to calculate economic and nutritional planes under different management and policy scenarios. Must interface with ecological model.	Increased capability to quantify and project human welfare responses to alternative management and policy scenarios pertaining to livestock-wildlife interactions.	Government agencies NGOs Development specialists Researchers	Model design Model coding Model testing Model validation Model implementation	P. Thornton K. Galvin T. McCabe A. Magennis R. Davis A. Mukhebi R. Reid E. O'Malley Graduate Students	5 years	Assessing and developing development alternatives which improve human welfare throughout the region.
Protocols for integration of data and model-based analyses at large spatial scales - for regional policy assessments of livestock-wildlife interactions.	Use in regional integrated assessments. Use of assessments for policy analysis. Policies which improve livestock-wildlife interactions.	Government agencies NGOs Development specialists Researchers	Regional data-base integration. Regional scale model implementation. Policy analysis. Integrated assessment.	M. Coughenour J. Ellis R. Davis T. McCabe R. Kruska R. Reid P. Thornton		

Objective 2: Develop and implement a demand-driven, integrated assessment and monitoring system for improving pastoral-wildlife interactions at site and policy levels.

Outputs	Impacts	End Users	Actions Required	Team Members	Time to Completion	Developmental Relevance
Implementation at 3 intensive sites (Ngorongoro, Kajiado, Lake Mburo). Possible later implementation at 3-6 additional sites (Laikipia, Tarangire, Karamoja, Turkana, Rukwa Valley, Awash N.P.). Assessments, and useful and accessible information.	1) Use by organizations which influence, or aim to influence natural resources. 2) Increased capacity to assess alternative management and planning scenarios 3) Increased sense of empowerment arising from better information 4) Improved relationships between conflicting land uses 5) Increased food security for pastoralists 6) Wildlife conserved, ecosystem integrity maintained	1) Site management and planning entities. 2) Government organizations and non-government agencies - e.g. pastoral, wildlife, livestock, parks. 3) Pastoralists, or their representatives - traditional, private, commercial, ranching, grazing associations. 4) Tourism industry. 5) Educational institutions. 6) Researchers 7) Media	1) Stakeholder inputs via workshops and forums. 2) Conduct field appraisals of ecology, wildlife, disease, livestock production, human welfare. 3) Assemble GIS data bases 4) Assemble non-spatial data bases 5) Establish information centers 6) Implement monitoring scheme	All US and ILRI. Host-country team members at corresponding sites. US site leaders: Kajiado- Ellis NCA - Galvin Mburo - Magennis In-country site coordinators: Kajiado: Rainey NCA: Moehlman Mburu: Mugishu	2-3 years per 3 sites. Six years total.	Implementations across sites with a diverse array of developmental problems, representing those encountered in pastoral development throughout the region.

Objective 2: continued

Uniform Method for Classifying Ecological Range Sites in Region	1) Adoption by government and non-government entities 2) Improved ability to conduct local through regional level assessments 3) Increased coordination among planning entities	1) Government and non-government entities. 2) Researchers	1) Background research 2) Regional workshop 3) Document preparation	D. Child L. Rittenhouse R. Kidunda J. Kinyamario, F. Banyikwa	3 years	Provides a widely accepted set of criteria for measuring state, and progress to management goals throughout region
Recommendations for management of livestock and wildlife to minimize disease. Recommendations for disease control	Decreased losses due to disease. Increased livestock productivity.	Pastoralists Farm managers, and owners. National Park personnel Government agencies NGOs.	Literature survey Obtain databases Identify questions and conditions Run Savanna model with disease component. Analyze and interpret results	J. Ellis M. Coughenour J. DeMartini P. Rwambo J. Grootenhuis (Others)	5 years	Enhances wildlife conservation and improves human welfare in pastoral development efforts throughout the region.

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Child, Dennis Dept. Chair, Professor	Colorado State University, Rangeland Ecosystem Science Dept., Fort Collins, CO	Leader, oversee range ecology research/Range Science	American/USA
Davis, Robert Senior Associate	University of Colorado, Institute of Behavioral Science, Boulder, CO	Scientist, oversee policy work/Political science, policy analysis	American/USA
DeMartini, James, Professor	Colorado State University, Pathology Dept., Fort Colins, CO	Leader, oversee veterinary research/Veterinary medicine	American/USA
Ellis, James Senior Research Scientist, Assoc. Professor	Colorado State Univ., Natural Resource Ecology Lab., Rangeland Ecosystem Science Dept.., Fort Collins, CO	Leader/Ecology	American/USA
Galvin, Kathleen Senior Research Scientist, Asst. Professor	Colorado State University, Natural Resource Ecology Lab., Anthropology Dept., Fort Collins, CO	Leader, oversee human ecology research/Anthropology, human ecology, nutrition	American/USA
Magennis, Ann Associate Professor	Colorado State University, Anthropology Dept., Fort Collins, CO	Scientist, oversee human demography and disease work/Anthropology, human biology, disease	American/USA
McCabe, Terrence Assistant Professor, Associate Director	University of Colorado, Anthropology Dept., Institute of Behavioral Science, Boulder, CO	Scientist, oversee land use work/Anthropology, culture, cultural ecology	American/USA
O'Malley, Elizabeth Ph.D. Candidate	University of Colorado, Anthropology Dept., Boulder, CO	Scientist/Anthropology, culture	American/Tanzania
Rittenhouse, Larry Professor	Colorado State University, Rangeland Ecosystem Science Dept., Fort Collins, CO	Scientist/Livestock ecology	American/USA
Kenya			
Barrow, Edward Community Conservation Advisor	African Wildlife Foundation, Nairobi, Kenya	Collaborator/Conservation	Irish/Kenya
Grootenhuis, Jan Veterinarian	Consultant, Nairobi, Kenya	Scientist, oversee vet research in Kenya/ veterinary medicine	Dutch/Kenya
Kinyamario, Jenesio	University of Nairobi, Dept. of Botany, Nairobi, Kenya	Scientist/ botany	Kenyan/Kenya

Team Member Name	Affiliation	Role/Discipline	Nationality/Residence
Kenya, continued			
Kruska, Russell GIS Specialist	International Livestock Research Institute, Socioeconomics Unit	Scientist, oversee regional GIS work/geographic information systems	American/Kenya
Mukhebi, Adrian Senior Agricultural Economist	International Livestock Research Institute	Agricultural Economist	Kenyan/Kenya
Rainy, Michael Ecotourism and Education Instructor and Consultant	Bush Homes of East Africa, Nairobi, Kenya	Consultant, and ecotourism and education instructor, oversee research at the Kajiado site/ecology	American/Kenya
Reid, Robin Senior Ecologist	International Livestock Research Institute, Socioeconomics Uni, Nairobi, Kenya	Scientist, ecology, regional analyses/Ecology	American/Kenya
Rwambo, Paul Veterinarian	Kenya Agricultural Research Institute	Scientist, conduct veterinary field research/Veterinary medicine	Kenyan/Kenya
Thorton, Philip Economist	International Livestock Research Institute, Socioeconomics Unit	Scientist, economic modeling/Economics	British/Kenya
Tanzania			
Banyikwa, Feetham Adjunct Faculty, Research Associate	Universityof Dar es Salaam, Dar es Sallam, Tanzania, Syracuse University	Scientist/ Plant Ecology	Tanzanian/Tanzania
Kidunda, Rashid Assistant Professor	Sokoine University, Faculty of Agriculture, Dept. of Animal Science and Production, Morogoro, Tanzania	Scientist/ Range ecology	Tanzanian/Tanzania
Moehlman, Patricia Biologist, Consultant	The World Conservation Union - IUCN, Equid Specialist Group, Tanzania	Consultant, oversee research at the Tanzanian site/ biology	American/Tanzania
ole Ikayo, Francis Director	Inuyaat e-Maa (Maasai Pastoralist Group), Tanzania	Consultant, oversee pastoralist input into research and development of the DSS/Human welfare	Tanzanian/Tanzania
Uganda			
Acen, Joyce Management Systems Officer	Uganda Ministry of Tourism, Wildlife and Antiquities, Kampala, Uganda	Scientist/ likely to be a graduate student	Ugandan/Uganda
Else, James Veterinarian, Institutional Development Advisor	Uganda Ministry of Tourism, Wildlife and Antiquities, Kampala, Uganda	Scientist, oversee veterinary research in Uganda	American/Uganda
Mugisho, Arthur Community Conservation Coordinator	Uganda Ministry of Tourism, Wildlife and Antiquities, Kampala, Uganda	Scientist/ oversee the entire research in Uganda	Ugandan/Uganda

Diversification of Livestock Assets for Pastoral Risk Management and Regional Development in East Africa

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Narrative Summary

In this assessment year we have developed a framework for implementing a program of applied research and outreach coordination that fits SR-CRSP guidelines for the theme entitled *Animal Production Systems for Pastoralists in East Africa*. The framework is a result of nine months of deliberation involving seven workshops in Utah and East Africa and an East African field tour. The basic tenet of our problem model is that we can significantly improve pastoral risk management through combinations of traditional and novel interventions which increase access to information, diversify assets and incomes, and increase access to external resources. Our proposed study region extends over 700 km in length from Hagere Mariam in southern Ethiopia through the Borana Plateau south to Marsabit and Isiolo, Kenya, and then westward to Maralal and the Baringo area. This region contains arid and semi-arid ecosystems occupied by about ten important pastoral and agropastoral groups. It contains a large number of important types of land uses and is beset by problems of rural poverty, pockets of refugees, ethnic conflict, food insecurity, banditry, and international border issues. It is also served by a near-intact international marketing transect for livestock with the main terminal point in Nairobi, Kenya. In short, the region is well-suited for examination of the issues we have identified, and is representative of a wide cross-section of situations relevant to the Greater Horn of Africa in general. We expect that improved risk management could set in motion an effective systems-level, policy-oriented series of outcomes that in tandem could help mitigate poverty, improve food security, enhance animal production, reduce environmental degradation, and contribute to regional economic growth and security. We have adopted a hierarchical approach with which we can dissolve disciplinary research boundaries, investigate issues, and prescribe inter-related interventions involving regional, sub-regional, community, household, and individual levels of resolution. Interventions are organized with respect to four cross-cutting systems which intersect all levels of the hierarchy, namely marketing systems, rural finance systems, natural resource tenurial systems, and systems which deliver social services. Our proposed team includes 11 core team members (ten researchers and one project liaison specialist) representing

six organizations. Another 17 individuals and three organizations have been identified as possible project collaborators pending identification of ancillary funding. Liaison links will be established with another 18 organizations in a regional network. The proposed project would be conducted in three phases over six years. Four post-doctoral associates and up to 14 graduate students would receive training. Five annual workshops for research and outreach are proposed, with the venue shifting on alternate years between Moyale on the Ethiopia-Kenya border and Logan, Utah. We seek to form a project advisory board comprised of five distinguished professionals to provide guidance for project activities.

Problem Model

Synopsis of Original Problem Model

The first part of our original problem model described a research theory based on literature and field experiences of several assessment team members. This model depicted cause-and-effect linkages concerning how internal pressure is generated in East African pastoral systems and the likely outcomes of such pressure for human welfare, livestock production, and environmental trend. The second part of the original problem model described an intervention concept that was postulated to effectively deal with the situation embodied in the research theory.

The central focus for the original problem model was based on observations conducted in the Borana pastoral system of southern Ethiopia during the 1980s. These observations indicated that system stability had been compromised due to loss of drought refugia (or fall-back areas) and that stocking rates of cattle exhibited an oscillating equilibrial pattern with a post-drought, rapid growth phase followed by a high-density phase of low growth, and ultimately a calamitous crash in herd numbers when even a modest dip in rainfall occurred. Stocking rates were thus viewed as a reliable predictor of system vulnerability in this semi-arid environment. Borana society experienced significant social stress during the high density phase when households sought to move cattle to distant locales to reduce the likelihood of a general crash due to low rainfall. All of this was interpreted to suggest that because Borana herd owners had experienced large herd losses in 1985 and 1991, and could now perceive they were caught in a "boom and bust" cycle. Observations made in Borana have been made elsewhere in East Africa to various degrees. Traditional social and managerial mechanisms to deal with the inherent stress and variability of arid and semi-arid ecosystems have been compromised by human population growth, land loss, environmental degradation, and government policies unfavorable to pastoral peoples. Surplus people routinely tossed out of pastoral systems then gravitate towards settlements, where they exacerbate social welfare problems and contribute to ecological degradation.

It was postulated that people like the Boran could now be ready for interventions to diversify their assets to include non-pastoral investments for wealth storage. This could entail stimulation of savings behavior (e.g., hedging) by "cashing-out" some livestock during the later stages of the growth and high density phases of the cattle population cycle in anticipation of a crash. Such wealth storage could have positive ramifications for facilitating opportunism and risk management among pastoral households, mitigating poverty and vulnerability to famine, and possibly generating capital for rural development if capital was recycled in formal financial systems. The presence of a commercial banking system in southern Ethiopia, largely un-utilized by the pastoral community, was viewed as a possible intervention partner. Intervention could be achieved through education and outreach as the basic pieces of the puzzle were already in place. Research of Solomon Desta, initiated with support from the SR-CRSP Small Grants Program (see the SR-CRSP 1996 Annual Report), was designed to evaluate the social and economic feasibility of this approach.

In the original approach it was speculated that research would be conducted in several distinct locations in East Africa to evaluate: (a) Accuracy of the cause-and-effect relationships postulated to drive changes in pastoral behavior; (b) variation in the spectrum of pre-conditions thought to pre-dispose a pastoral society to engage in non-pastoral asset diversification; and (c) variation in local solutions to the problem. Study sites that offered possibilities to examine longitudinal data and also differed in terms of degree of aridity, degree of system-altering pressures, economic development, and socio-cultural features that were thought best to fill an analytical matrix. It would not matter if sites were contiguous or not. For example, sites in arid Turkana (Kenya), semi-arid Kajiado Maasailand (Kenya), arid Afar territory (Eritrea and/or Ethiopia), and semi-arid Borana (Ethiopia) were prominent in preliminary plans.

Evolution of the Problem Model

The original problem model was revised by the Assessment Team (AT) in a series of workshops, field tours, and informal discussions over nine months. Other details of these deliberations are reviewed later in this report. The general outcome of the iterative process of problem-model evaluation and regionalization can be summarized in the following points, which are listed below in rough chronological order. If an outcome was strongly related to grass-roots inputs from potential project beneficiaries or end-users, including pastoralists or people working front-lines of research or development problems, an entry is followed by [GR]; if an outcome was more related to regional inputs from either of the East African AT workshops or internal meetings on the field tour this is denoted by [ATW-East Africa]. Finally, if an outcome was most influenced by Utah AT workshops this is denoted by [ATW-Utah].

General Developmental Relevance

The general problem model was strongly endorsed by the Borana leadership in southern Ethiopia in August, 1996. The forum for debate was the Gumi Gayu meeting, which is a pan-Boran cultural and political meeting held once every eight years. In 1996 it was attended by 3,000 pastoral leaders. The need for alternative investment or savings complementary to livestock was forwarded as one of the top proclamations of the 1996 meeting. Following the Gumi Gayu a seminar on the problem model was presented to about a dozen senior staff of Commercial Bank of Ethiopia (CBE) in Addis Ababa. The leaders of CBE felt that the project concept was also very consistent with changing goals of their organization and liberalization of the Ethiopian economy. Economic liberalization is projected to greatly accelerate demand for loan capital nationally, and CBE needs to broaden it's quest for such capital. The general developmental relevance was also endorsed at East African workshops and in the field tour described in a later section of this report. [GR] [ATW-East Africa]

Study Area

The preliminary study site concept was dropped in favor of having all sites occur within one international study region extending 700 km from southern Ethiopia (i.e., Hagere Mariam, Yabelo, Negele, Mega, Moyale, etc.) to northern and north-central Kenya [Marsabit, Isiolo, Maralal, Marigat (Baringo)]. This was viewed as a superior design concept for several reasons:

- several important pastoral groups (i.e., Boran, Gugi, Samburu, Rendille, Gabbra, Somali, El Chamus, Pokot, etc.) and a wide variety of local climates and pastoral development situations occur throughout the region, and these would ably provide the diverse elements needed to fill an analytical matrix introduced above;
- the sites lying between Hagere Mariam and Isiolo comprise an important regional (international) livestock marketing chain with implications for cross-border policy issues. Where terminal markets are concerned the marketing region can be broadened to include Nairobi and Dilla or Shashamene (the latter are large urban areas in southern Ethiopia). The predominant pattern is for cattle to be marketed south to Nairobi; and
- use of such a study region would allow for many more analytical options. These include studies of regional market flows and interactions among various pastoral sub-systems, livestock, and climate using spatial hierarchical modeling techniques. Because of this decision to focus on southern Ethiopia and northern Kenya as one economic and ecological region the field tour was targeted as such.

Eritrea was discounted for a couple reasons: (a) the information base relative to pastoralists in Eritrea had been overestimated, and Eritrea was judged less important in relation to project objectives than originally thought; and (b) Eritrean officials did not respond to our communications. [ATW-Utah]

Problem Model Research Concept

In general, the problem model concept of cause-and-effect for pressure generation in East African pastoral systems has been endorsed from a variety of angles. It was a common perception among front-line development groups that crashes of pastoral livestock populations were occurring at a greater frequency and amplitude in recent times compared to the past. In some cases there appears to be a mix of density-dependent and density-independent interactions involving climate and livestock, but this was expected when a mix of arid and semi-arid systems are considered. The main driving factor of pastoral land loss was endorsed most strongly for areas in Kenya where pastoral zones gradually merged with higher-elevation sites (e.g., Maralal, Isiolo, Marsabit, etc.). Land loss due to gradual environmental degradation was cited as more important for arid northern Kenya. Banditry plays a much larger role in insecurity and reduced access to pastoral lands in Kenya than Ethiopia. In recognition of this heterogeneity the AT decided that "aggregate challenge" was a better means to describe pressure-generating phenomena for a given system (see below).

Most of the front-line development organizations in Kenya felt that livestock marketing constraints were the biggest problem facing pastoralists because markets either totally collapse during the early stages of drought or have insufficient capacity to handle the higher throughput associated with drought. Preliminary data collected by Desta (in progress) for 330 Borana households in southern Ethiopia indicate that: (a) the people strongly confirm the conceptual model of increasing system instability and declining pastoral fortunes; (b) they have interest in non-pastoral investments and are not precluded by cultural mores from making non-traditional diversification decisions; (c) they are commonly unconnected to neighboring settlements in terms of investment opportunities; and (d) they have a general awareness of what local bank branches do, but feel such access is "only for wealthy non-pastoralists." [GR], [ATW-East Africa]

Problem Model Research Plan

A draft organization of the research plan was produced in Utah during the November and February meetings. The cornerstone of this draft plan was elaboration of the problem model into five interdisciplinary issue sets. These were intended to break-up disciplinary barriers and form the structure for varied subgroups to address different research problems across a series of yet-to-be determined field sites within the study region. The final research plan, which was a modification of the issue set approach, was not elaborated until the last AT workshop in Utah during early May. It was intended to wait until the field tour was over in April before a final design concept was forwarded. The main intent of both East African workshops, therefore, was to take the audience through the cause-and-effect issue sets of pressure generation in East African pastoral systems and give a crude, preliminary rationale as to how the research could be implemented. This created some confusion, especially in the Nairobi workshop. The outcome ultimately compelled us to reorganize the issue sets as a subset of a spatial hierarchy whereby questions are first nested according to spatial unit (i.e., region, community, household, intra-household, etc.) and clarify project objectives and research questions. [ATW-East Africa] [ATW-Utah]

Problem Model Outreach

Despite general agreement about the accuracy of the problem model concept, there was more heterogeneity among front-line development agents with regards to potential solutions for reducing pressure for pastoral societies in the study region. Some highlights of our interpretations are summarized below using four categories of outreach activities. A few outreach activities could fit in more than one category, however. Several development agents are regularly involved with research to better target their activities. Consultancies commissioned for livestock marketing, small-scale enterprise, land-use, natural resource management, improved use and marketing of indigenous natural products, pastoral coping strategies, etc., were common.[All information below generated from GR]

Virtually all development agents agreed that pastoral economic diversification and improved risk management were important strategies, but each development agent is pursuing a slightly different spectrum of activities depending on location, resources, and institutional capabilities. In general, initiatives across-the-board seem to be better established in northern Kenya compared to southern Ethiopia. Most agencies are involved in a combination of development and crisis response. During non-crisis years, development activities are pursued while during crisis years relief-type activities prevail. Currently 1996-97 was regarded as a crisis year due to drought in the study region. We have categorized existing outreach activities as follows:

Helping pastoralists better cope with acute stress— short-term strategies. These efforts are commonly aimed at trying to predict the onset of crisis over the short term (i.e., pending livestock deaths in the next few months due to onset of drought), and then facilitating a coping response by pastoral households and/or relief agencies. These efforts in Kenya are organized by district and are implemented by agents such as the Arid Lands Resource Management Project (ALRMP) and the Drought Preparedness Intervention & Recovery Program (DPIRP); in southern Ethiopia CARE and other agents are implementing smaller-scale programs. The approach includes use of drought early-warning systems using enumerator networks and analysis of data from monthly household surveys. When data indicate a subpopulation is under severe stress, the agency can mobilize emergency livestock sales or delivery of food relief in some cases. There were a few instances in Kenya where an agency subsidized or otherwise facilitated emergency livestock purchases by traders in remote areas. In another case a Gabbra pastoral cooperative in far northern Kenya has invested in a large lorry to improve their marketing responsiveness. Market information systems have been developed by German Technical Cooperation (GTZ) for northern Kenya which relay terminal market prices in Nairobi via fax.

Helping pastoralists better mitigate stress— medium-term strategies. These efforts deal more with trying to reduce the severity of crisis for pastoral households before crisis occurs. This can involve asset diversification and formation of producer cooperatives in some cases. Asset diversification initiatives are widespread but apparently small-scale to date. Several agencies (GTZ, FARM-Africa, etc.) are involved with diversification of pastoral cattle herds using camels and/or camel husbandry in general. Some are involved with establishment of producer cooperatives and women's groups who are establishing savings accounts for future projects. Pastoral banking appears most constrained due to lack of accessibility to pastoralists as well as by banditry which limits mobile banking outreach in Kenya by Kenya Commercial Bank (KCB). A pilot project conducted by CARE in southern Ethiopia is seeking more grass roots information pertaining to perceived needs for alternative investment and asset diversification among the Boran. This project has documented that interest in alternative investments seems to be rising in some cases due to recent large losses of animals experienced by herd owners in 1985, 1991, and late 1996.

Helping pastoralists better mitigate stress—longer-term strategies. This approach deals more with trying to address the underlying problems of land loss and need for human emigration out of pastoral areas which are congested. There are a few projects starting to deal with reclamation of bush-encroached, pastoral grazing areas in both Kenya and Ethiopia (i.e., GTZ, CARE, Save the Children/USA, etc.). Development or rehabilitation of water points is more common. The role of agencies to facilitate conflict management among neighboring pastoral groups is gaining a higher profile. Near Isiolo, Kenya, some development agents have brought in pastoral advocacy panels to mitigate against consideration of unfavorable land tenure policies by local politicians or land annexation to outsiders. Most development agents are involved with some form of education promotion for pastoralists and improving opportunities for pastoral women. At one extreme, the NGO called SALTLICK (or Semi-Arid Lands Training and Livestock Improvement Centres of Kenya) runs what resembles a vocational school for pastoralists out of several locations in northern Kenya. In several other cases education includes veterinary outreach for animal husbandry. It was mentioned that government support for rural education, health, etc., was expected to decline in Kenya; the picture is less clear for Ethiopia which is still undergoing regional transformation of government.

Helping former pastoralists rehabilitate themselves. This approach commonly involves income diversification and re-stocking. The beneficiaries for these activities are often households which have been squeezed out of the pastoral sector; this population has reportedly been growing. In other cases, women from poorer pastoral households are interested in these activities. Income diversification is most often of interest to former pastoralists and poorer pastoralists who have more time to invest in collection of natural products (e.g., tree gums, honey) or manufacture of new products (e.g., alternative fuel bricks). This niche is mostly occupied by SALTLICK, but others are also involved in various aspects. Some households in northern Kenya have been re-stocked with animals, but monitoring outcomes of such activities is very limited. Once former pastoral households become settled it is often difficult to get them interested in moving back into the pastoral sector. Marketing constraints at national and international levels also appear to limit the utility of some income-diversification activities; for example markets for gum arabic and related compounds appear saturated (A. Hersi, SALTLICK, pers. comm.).

Although development agencies are often doing similar things, they can complement each other by working in different sites. Virtually all activities summarized above are externally funded, with limited cost-sharing in some cases by national governments. District-level boards coordinate development and relief activities in Kenya. Interestingly, we had little evidence that development agents were pre-occupied with classical foci of pastoral range issues, namely implementation of range livestock production improvement practices based on changes in grazing management. In the vast majority of cases the priority of development agents was assisting pastoralists to make transitions within a changing world.

Key Elements of the Revised Problem Model

The core of the problem model essentially remains unchanged as a result of the iterative process. The overarching themes of pastoral systems being under pressure, the emerging importance of pastoral risk management, and the development priority of how to improve pastoral risk management have all survived intense scrutiny. The main alteration, however, is the recognition that promotion of savings (i.e., hedging) behavior among pastoralists is important, but only one of several options that could be studied and implemented. Some definitions and main findings are summarized below:

By "risk management" we collectively refer to methods which reduce the likelihood of negative outcomes associated with risk (e.g., quantifiable, such as the probability that next year will be a dry rainfall year) and uncertainty (e.g., non-quantifiable, such as the likelihood that next year will feature political upheaval). The shocks which epitomize driving variables that lead to risk or uncertainty can take numerous forms; examples of shocks include those related to: Climate (e.g., forage supply); market price fluxes for animals, animal products, and grains; sudden changes in provision of social services; epidemics; and loss of resources due to insecurity and political change.

Risk management can further take the form of either coping strategies *(ex post)* or pre-emptive mitigating strategies *(ex ante)*. Examples of each have been previously reviewed in the activity lists of development agencies. Facilitation of emergency livestock sales, provision of timely market information, distribution of food aid, and to some extent income diversification and conflict management, tend to be coping strategies. Encouragement of alternative investment, asset diversification, improvements in marketing infrastructure, camel husbandry, education, small business, bush control, and family planning tend to be mitigating strategies.

Our central hypothesis is that improved capacity to mitigate risk and uncertainty at individual, household, community, and regional levels will improve the well-being of pastoral peoples and the quality of the natural environment on which they depend.

There are three main avenues through which people mitigate or cope with risk and uncertainty:

- improved flows of information;
- diversification of assets and income; and
- improved access to external resources.

Examples of information in the context of our project could be: terminal market prices; the likelihood that next year will be a dry rainfall year; existence of disease outbreaks, etc. Examples of assets to be diversified include livestock as well as human capital. Examples of income diversification sources include gathering and sělling natural products (e.g., honey, gum arabic, etc.), producing handicrafts, other small business activities, revenue sharing from wildlife parks, etc. Examples of improved access to external resources include reclamation of grazing land, legalized and secure land tenure arrangements, and sustainable improvements in water supply which opens up new areas for livestock to forage.

Comprehensive Project Vision Statement

Despite the complexity implicated in the revised problem model, there are examples where all major elements of the problem model can be tied together in an integrative whole. Risk management interventions would most likely occur in somewhat of a stepwise fashion, as some are more readily implemented and yield quicker returns than others. In addition, some interventions form foundations for other interventions. For an example of a mitigating strategy, livestock asset diversification, although not perfect, would probably be more viable and yield faster benefits to households, communities, and the environment than putting too much hope in the view that pastoralists could easily re-establish control over formerly annexed lands or begin to engage in family planning. One example of a vision statement is below:

The first cornerstone of a regional strategy is encouragement of livestock asset diversification into non-traditional forms. This process involves an alteration in household-level investment tactics from an unbridled re-investment in livestock, regardless of stocking rate, to instillment of a hedging behavior that advocates re-investment contingent on stocking rate and other types of production and market information. Ultimately, a region-wide hedging behavior among pastoralists could result in a more conservative, but still opportunistic, range of stocking rates that minimizes the regular (and often large) wastage losses of animals for households and thereby modify the "boom and bust" cycle for livestock numbers by resulting in a pattern having longer periods between herd crashes that have lower amplitudes. This system transformation should result in a less-variable annual throughput of livestock to market, which would be more favorable to sustaining marketing chains compared to the highly variable conditions of the past. Access to non-pastoral investments could enable people to better manage stocking rates to benefit wealth accumulation, animal production, and household livelihood security. More conservative stocking rates could also mitigate the likelihood of further environmental degradation *from over-grazing. Creation of accessible avenues for alternative investment has implications for underwriting an economic revitalization of settlements and providing capital for investment in regional marketing infrastructure, and could permit expansion of public services now under threat of abandonment by government. Investment in education, both on a personal and public basis, would be vital for successful diversification of human capital assets, which is the ultimate "solution" to the current pastoral dilemma. Alternative wealth storage could provide for families to transmit savings to future generations and also permit the flow of funds back into rural communities in the form of projects for land restoration, reclamation, or water development. They could also flow back as credit for herd rebuilding and affect destitute former pastoralists living near settlements. All of these channels could therefore increase access of pastoralists, and former pastoralists, to "external resources" and further affect a positive cycle of enhanced capability for risk management.*

In summary, the vision statement above incorporates all three elements of risk management that were previously listed. Livestock asset diversification is the primary tactic, and it requires timely information on market and environmental conditions to be implemented most efficiently. Capital generation from livestock asset diversification then flows as investments in:

- rural education and economic development, which strengthens possibilities for diversification of human assets and non-pastoral income-generating options; and
- improvements in the natural-resource base of communities, which strengthens access to external resources (i.e., resources that prior to rehabilitation were less accessible).

In the sense that livestock asset diversification could also result in herd diversification (i.e., from domination by cattle to include some camels), and opportunistic regulation of stocking rates could increase milk production due to mitigation of density-dependent interactions among livestock competing for forage, livestock asset-diversification could also directly affect income streams and the diversity of income in the form of milk. Other integrated examples of risk management are possible.

Improved information with regards to prices or weather prediction would enable pastoralists to make the appropriate decisions whether or not to re-invest in livestock. Marketing now becomes crucial in the problem model because the limits of animal marketing in an "average" year then dictate the extent to which a system can be monetized and economically diversified. It is unclear whether the marketing region which defines our project area could offer the demand necessary to allow all of the pastoral groups to increase their marketed output.

In general, the project has put forth a vision statement to achieve impact and seeks to answer the question "why not?" Constraints will vary according to various cultures, resource endowments, sources of risk and uncertainty, and different scales of space and time. Communities, households, and individuals are differentially vulnerable to various mixes of external shocks and thus different packages of risk management interventions will be required.

Assessment Team Process and Progress

Review of the Process and Progress

Basically, we were able to conduct more activities during the AT year than we had originally planned. We exceeded our expectations in virtually every respect. In our AT proposal we had planned for three Utah-based workshops, one East African field tour, and one year of pilot data collection in southern Ethiopia. The workshops were intended to provide a forum for iterative model evaluation, while the field tour was intended to assess developmental relevance and obtain grass roots input for iterative processes in Utah. By the time the AT period is finished, however, we will have completed all of the above plus one more Utah-based workshop and four East African workshops. In summary our activities have included:

- four workshops in Logan, Utah, during November, February, March and May that were largely attended by AT members;
- one formal workshop held in southern Ethiopia in February that involved local Government Organizations (GOs), Non-Governmental Organizations (NGOs), and staff from Commercial Bank of Ethiopia (CBE);
- two other workshops held in Nairobi and Addis Ababa during March and April where the problem model was reviewed in a forum of 24 to 28 local and international professionals representing pastoral research and development in each country;
- a field tour of central and northern Kenya and the Gugi region along the northern edge of the southern Ethiopian rangelands; this was conducted by AT members from late March to early April. During the field tours the AT met representatives of another ten development or aid organizations (GOs and NGOs) and also conducted internal discussions on the problem model; and
- one AT member will have attended another workshop on crisis mitigation in East African livestock systems in July.

Finally, the pilot data collection has been successful and occurred among 330 Borana households which reside within 25 km of four settlements in the southern Ethiopian rangelands (Desta, in progress; see SR-CRSP 1996 Annual Report). CARE-Ethiopia has conducted some pilot outreach among other Borana households concerning herd dynamics and alternative investment strategies (Jatani, in progress). The original problem model was discussed among pastoral leaders at the Gumi Gayu meeting and among senior staff of Commercial Bank of Ethiopia (CBE) in August, 1996 (noted above).

Future Activities

Our general time line for the project is divided into three phases. In general, the first phase deals with regional survey and system description. This will provide the basis for site selection for intensive case studies conducted in Phase II. From six to ten master's-level graduate students will conduct most of the field work in Phase II, and this field work will be closely supervised by post-docs. Phase II will deal more with local diagnostics of what risk management interventions are needed and why. A Phase III will involve one Ph.D-level graduate student and relatively more effort by scientific team members in synthesis, modeling and policy evaluation. The plan can be briefly summarized as follows:

Phase I (15 Months from October, 1997, to January, 1999)

We plan to hire one or two experienced field people, preferably one social scientist and one livestock/range ecologist, to undertake a general survey of the project region. They would describe the hierarchical structure of the pastoral systems, characterize the various sources of internal pressure and external shocks which affect the systems, and also answer some questions pertaining to livestock markets, rural financial systems, land tenure issues, and public service delivery. Some of these activities would extend beyond Phase I. A project liaison person would also be in the field for two months in mid- and late-1998 to make links to important development agents in-region. Project co-leaders would make supervisory field visits by July, 1998. In January, 1999, a workshop would be held in Moyale, on the Ethiopia-Kenya border to discuss survey and outreach findings; this workshop would be open to all research and outreach collaborators (see below). A project Advisory Board (AB) would also attend and this entity is intended to be made up of distinguished professionals who provide strategic guidance to the project. The debate concerning which sites would be included in Phase II of the project would begin in earnest at this first Moyale workshop. Collaborative activities among research and outreach entities will also be reviewed. About four master's candidates (MA) would already be matriculated at universities in East Africa (i.e., two at Egerton University (EU) and two at Addis Ababa University (AAU), supervised by African faculty who would be team members). During this first year these students would be wrapping-up coursework and preparation of research proposals.

Phase II, Part One (20 Months from February, 1999, to September, 2000)

The two field staff return to Logan, Utah, for a couple months of synthesis and write-up of results. Selection of final study sites for Phase II would be completed. A second set of four master's level students would be matriculated at Utah State University and University of Kentucky by February, 1999 for a year of coursework and proposal preparation. Two new post docs would be hired to serve as coordinators for the next part of the project which is data-intensive for a selection of key sites. Research would entail a wrap-up of any lingering Phase I activity and commencing on research objectives dealing with diagnostics of local risk management interventions. The post docs would be in the field by May, 1999, and would be joined by the four MA students from EU and AAU who would live and collect data at the study sites. The MA students would be in the field for a full year. Project co-leaders would make supervisory field visits by mid-1999. The second project workshop would be held at Logan, Utah, in January, 2000. Team members, post docs, selected students, and the AB could all be invited. Work results would be reviewed and the project re-oriented where necessary. The first group of students would leave the field by June, 2000, to analyze their data and write and defend their theses. Preliminary results of the field work of these students should be ready by September, 2000. The second group of four students would be placed in the field by May, 2000, and complete about five months of data collection by September, 2000. A third (and final) group of four students would be matriculated at EU and AAU for coursework and proposal preparation. The project liaison person would complete another two months of outreach activity in 1999 and another month by mid-2000 to complete outreach objectives. Finally, a Ph.D student would be matriculated at USU in 1999 to begin two years of coursework and proposal preparation to deal with modeling and policy analysis in Phase III (see below). By September, 2000, therefore, 16 months of completed work by two post docs, five months of work by the project liaison person, and on-going work of eight master's students would help form the basis to justify project continuation for the final three years. If the work of the liaison person is deemed satisfactory we would seek support for this activity for the last three years of the project, focusing on completing reciprocal links between research and outreach.

Phase II, Part Two (32 Months from October, 2000, to May, 2003)

This is a continuation of the same activities started in Phase II, Part One. The third workshop would again be held in Moyale in January, 2001, preceded by another month of activity by the liaison person. This workshop would have similar invitees as the first Moyale workshop and a continuing agenda to report and monitor progress of the project for both research and outreach. Representatives of other ASARECA countries (defined below) or development agencies who desire involvement in subsequent expansion of the project could also attend this workshop. The first group of students at EU and AAU should be finished with everything by May, 2001. The second group of four students would wrap-up their field work by April, 2001, and return to the USA for data analysis, write-up and thesis defense with the expectation they would finish by May, 2002. The third group of four students would commence field work by April, 2001, and after two years for field work and write-up they would finish by May, 2003. The post docs would be kept on to assist with wrap-up and synthesis and would finish by mid-2002. A fourth workshop would be held in Logan in January, 2002, with a fifth (project closing) workshop in Moyale in August, 2003.

Phase III (24 Months from October, 2001, to October, 2003)

This Phase has some overlap with Phase II. Phase III comprises the last two years of the Ph.D project dealing with research objectives for policy analysis and simulation modeling of system behavior. This student will be closely supervised by co-leaders of the project and will undertake a campus-based systems analysis, simulation modeling and policy evaluation based to a large extent on data generated from the student field projects. This Ph.D candidate may visit the study region, but will not undertake extensive field work.

Abstracts and Workshops

Workshops

L. Coppock, C. Barrett, P. Little, D. Bailey, J. Moris, D. Dahl, J. Dobrowolski, J. Eisenhauer and R. Ford. First AT planning workshop, 11-13 November, 1996. Utah State University, Logan, Utah.

L. Coppock, C. Barrett, P. Little, D. Bailey, and J. Moris. Second AT planning workshop, 20-22 February, 1997. Utah State University, Logan, Utah.

S. Desta and J. Holtam et al. Banking outreach workshop, 23-25 February, 1997, Yabelo, Ethiopia.

L. Coppock, C. Barrett, D. Dahl, D. Bailey, J. Moris, and R. Thurlow. Third AT planning workshop, 13 March, 1997. Utah State University, Logan, Utah.

L. Coppock, D. Bailey, S. Desta, J. Holtam, P. Little, and J. Moris et al. Kenya AT planning workshop, 25 March, 1997. International Livestock Research Institute, Nairobi, Kenya.

L. Coppock, D. Bailey, S. Desta, and J. Holtam et al. Ethiopia AT planning workshop, 8 April, 1997. International Livestock Research Institute, Addis Ababa, Ethiopia.

L. Coppock, C. Barrett, P. Little, D. Bailey, J. Moris, S. Desta, J. Holtam, S. Ehui, F. Chabari et al. Fourth and final AT planning workshop, 5-7 May, 1997. Utah State University, Logan, Utah.

Objective 1 (Phase I): Research - Determine regional aspects of livestock population dynamics and livestock marketing.

Outputs	Impacts	End User	Actions Required	Team Members	Time to Completion
Internal Research Reports	On other project aspects	Researchers	Literature review, collate government reports, data, field surveys	Coppock, Little, Bailey, et al.	18 mo.
Peer-reviewed publications	Increase awareness	Researchers, policy makers	same as above	same as above	24 mo.
Popular publications	Increase awareness	NGOs, policy makers	same as above	same as above	24 mo.

Developmental Relevance: We expect that refugia loss, insecurity, disease, drought, etc., interact to exacerbate livestock losses; more reliable markets reduce wastage losses in some cases.

Objective (Phase III): Research - Determine system-level outcomes of traditional versus non-traditional risk mitigation.

Outputs	Impacts	End User	Actions Required	Team Members	Time to Completion
Internal Research Reports	On other project aspects	Researchers	Data synthesis, simulation modeling, results validation	Barrett, Coppock Little, et al.	5 yrs
Peer-reviewed publications	Increase awareness	Researchers, policy makers	same as above	same as above	6 yrs
Popular publications	Increase awareness	NGOs, policy makers	same as above	same as above	6 yrs

Developmental Relevance: We expect to capture system-level herd dynamics and system-level outcomes for wealth generation and accumulation based on various risk mitigation scenarios.

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PRESENTATIONS

L. Coppock. Banking livestock capital for opportunistic management of stocking rates: a viable intervention for pastoral Africa? Invited research seminar presented to staff of the International Livestock Research Institute, 14 April, 1997. Addis Ababa, Ethiopia.

L. Coppock. Diversification of livestock assets for pastoral risk management and regional development in East Africa. Invited research seminar presented to faculty and staff of the College of Agriculture at Hohenheim University, 17 April, 1997. Stuttgart, Germany.

Team Member Name	Affiliation	Role/Discipline	Nationality/Residence
United States			
Coppock, Layne Principal Investigator, Associate Professor	Utah State University Dept. of Rageland Resources Logan, UT	Animal Science, Ecology	American/USA
Little, Peter Co-Principal Investigator, Professor	University of Kentucky Dept. of Anthropology Lexington, KY	Anthropology, Economics	American/USA
Barrett, Christopher Assistant Professor	Utah State University Dept. of Economics Logan, UT	Co-PI; Economics, Policy	American/USA
Dahl, Drew Associate Professor	Utah State University	Economics	American/USA
Falconer, Alan Professor	Utah State University	GIS/Remote Sensing	British/USA
Bailey, Dee Von Professor	Utah State University Dept. of Economics Logan, UT	Team Member; Livestock, Marketing	American/USA
Moris, Jon Professor	Utah State University Dept. of Sociology, Social Work, Anthropology, Logan UT	Policy, Applied Anthropology	American/USA
Ethiopia			
Desta, Solomon Post-Graduate Fellow	International Livestock Research Institute	Livestock Economics	Ethiopian/USA
Ehui, Simeon Head of Livestock Policy Analysis Program	International Livestock Research Institue	Agricultural Economics	Ethiopian
Holtam, Jordan Borana Project Coordinator	CARE International in Ethiopia Private Consultant Addis Ababa, Ethiopia	Team Member; Liaison	American/USA

Role of Animal Source Foods in Diet Quality and Growth and Cognitive Development in Eastern African Children

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Narrative Summary

For optimal physical growth and cognitive development, children require diets that are adequate in calories as well as micronutrients, particularly iron, zinc, calcium, vitamins A and B_{12}. Modest amounts of animal source foods can supply these needed micronutrients in the most efficient and digestible way. Observational studies in Kenya and elsewhere have shown that children who consumed meat in their diet consistently grew better and scored higher on cognitive function tests and school performance than those who ate little or no meat. The predominant diet in East Africa consists mainly of cereals and/or starchy roots, with little or no animal products.

The problem of poor diet quality was analyzed as having two main aspects: (1) limited availability of livestock and other small animals to the rural poor and (2) low utilization of animals for household consumption. Lack of resources to purchase animals; high cost of veterinarian services; inadequate farm size for grazing or growing fodder; and deficient agriculture extension services and education contribute to the problem. Women, the main caretaker, are often denied ownership and decision-making about animal management.

Utilization of animals for dietary improvement is hampered by lack of awareness by families about the essential role of animal source foods in promoting health, growth and development of children. Cultural beliefs may deprive children and women of meat. Inadequate preservation and safe storage of animal products and the high purchase price of animal products also limit consumption of animal source foods.

Under the Assessment Grant, multidisciplinary Assessment Team gathered information about the identified problem through workshops, site visits, and rapid field assessments of potential field sites. Community input was obtained through focus groups, individual and group interviews of key informants, and small sample household surveys. Nutritional status and dietary information were obtained from the literature and limited field observations.

A long-term project proposal is being submitted to improve diet quality through the increased use of animal source foods. The two principal activities will be (1) a controlled intervention trial to determine if daily meat intake will improve the growth and cognitive function of 6-8 year old children and (2) community interventions in Kenya, Ethiopia and Uganda working collaboratively with the community and NGOs, which promote livestock and small animals for poor households. Intensive practical participatory nutrition education of the families and extension workers will be a major activity to increase utilization of the animal food in the diet. Increased income of the households through the sale of surplus animal products and improved household food security are also intervention objectives.

An important policy issue is the promotion of sustainable food-based solutions to micronutrient deficiencies, rather than nutrient distribution schemes. Linkage between livestock production and human nutrition improvement at the policy, planning and implementation level is a ground-breaking development.

Problem Model

Background

Research findings from the Nutrition Collaborative Research Support Program (NCRSP), a longitudinal observational study in Kenya, Mexico and Egypt showed a positive association between animal source foods in the diet and physical growth, cognitive development and school performance. This was true even after controlling for total energy intake, socio-economic (SES) factors, parental education and social factors (1, 2, 3).

The predominant diet in Eastern Africa contains little or no animal source foods, is low in fat and is largely cereal or tuber-based. The resultant intakes are thus low in energy and micronutrients, particularly of zinc, iron, preformed vitamin A (retinol), calcium and vitamin B_{12}. Moreover, the high phytate and fiber content in cereals and the low heme protein in the diet reduce the bioavailability of iron and zinc (4, 5).

Micronutrient deficiencies, particularly iron, zinc, and vitamin B_{12}, especially in young children and child-bearing women, have serious functional consequences. Early onset of stunting in children, anemia related to iron and/or vitamin B_{12} deficiencies, vitamin A deficiency with decreased resistance to infection and blindness, and diminished cognitive function and poor school performance are associated with micronutrient deficiencies (2, 5, 6). Furthermore, protein-energy malnutrition (PEM), high infection and parasitic burdens and widespread iodine deficiency aggravate these deficiencies and their consequences, particularly in young children and women of reproductive age (7).

Food insecurity is a chronic and recurring problem for smallholder subsistence farmers in Eastern Africa dependent on rainfall and often farming on marginal land (8). Where the diet is inadequate in energy, micronutrient intakes are proportionately low.

Evolution

The Problem Model (PM) has passed through several iterations, from a very general statement in the original Assessment Proposal to a comprehensive and global model fashioned at the first Assessment Team workshop by the group as a whole. The Problem Model was further modified and scaled downed during the recent May workshop at Entebbe, in light of information gathered through field work and literature review. The latest version becomes a logical framework for the proposed research and community interventions. The PM includes factors which are amenable to intervention.

Conceptual Framework

The Problem Model (PM) will serve as the conceptual framework for the proposed research and intervention components (Figure 1). In developing the PM, two main sets of issues have been delineated by the Assessment Team (AT): availability of animals to poor rural households and utilization of animals and their products for food, either directly consumed or purchased from income generated by the sale of their animals and/or animal products. Availability and utilization are considered at several levels — household, community, national and multi-country regional levels, but the household and community levels are the primary focus. Policy is considered on national and regional levels.

The Problem Model addresses the determinants of animal availability and utilization rather than the bioscientific aspects of animal production. The following categories of factors are considered: socioeconomic, cultural, educational, demographic, gender-related, ecologic/environmental, infrastructure, and policy.

The two core concerns of this project are:

1) how to make animals available in sufficient number, quality, and variety, and accessible to poor rural families; and
2) how to promote household utilization of animals and their products for consumption and diet improvement, income generation, and improved food security. The factors and determinants that limit availability and utilization are described. The project will include relevant research and appropriate feasible interventions.

Problem Analysis

Availability of Animals

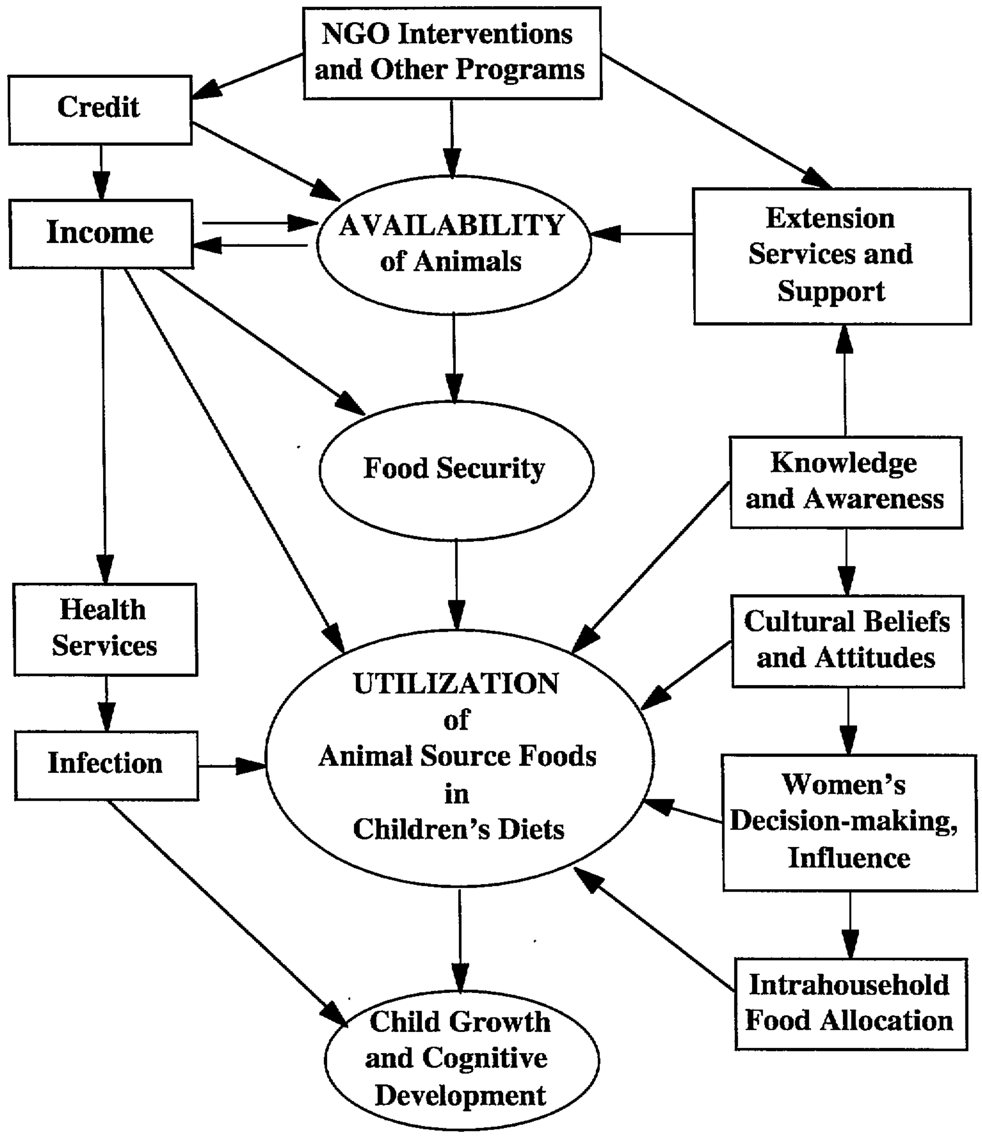
Factors which limit availability of animals to smallholder subsistence farmers for household consumption and/ or income generation are considered at the household, community, national, and regional levels.

Household and Farm Level Factors:

- Lack of cash or credit to obtain animals and provide inputs to maintain and breed animals limits availability. Farmers cannot afford to purchase animals or obtain the inputs needed to maintain, care for and cross-breed the animals, given the high cost of veterinarian care, medicines, vaccinations and artificial insemination. Costs of fertilizer to grow fodder, obtaining improved fodder seeds, water and sufficient farm size are also obstacles.

- Farmers lack up-to-date information

Figure 1: Problem Model



concerning animal husbandry and farming systems for improved care and breeding of animals in an affordable and environmentally sound manner. Local level on-farm extension education and services to support the care, maintenance and management of animals are sporadic or absent.

- Farm sizes become progressively smaller and/or farmers settle on marginal land because of increasing population pressure. Small farm size limits grazing opportunities and the ability to raise sufficient quantities of fodder for zero-grazing.

- Although women carry out most of the care-taking tasks, especially for goats and small animals, few agricultural extension workers are women and existing programs are not adapted toward women's lives.

- Women lack control over decision-making concerning the sale or purchase of animals.

Community Level Factors:

- The community or district infrastructure for agriculture and livestock is essential for optimal breeding and maintenance of the health of animals. Preventive services such as dips, vaccination programs, veterinarian services, artificial insemination, and extension education are often lacking or generally poor.

- Few markets are available close to home for families to buy and sell animals and animal products.

- There are few community credit schemes to support the purchase of animals.

National and Multi-Country Regional Level Factors:

- Current government policies or those of the private sector do not sufficiently promote livestock production to benefit smallholders.

- Pricing policies and subsidies do not sufficiently promote the breeding and production of improved animals and make them more affordable to small farmers.

Utilization of Animal Source Foods in the Diet

If animals become more available to households through successful NGO and/or governmental schemes, this does not assure improvement in diet quality of children and women. The following barriers to utilization of the animals or their products for consumption have been identified:

Household and Farm Level Factors:

- Families lack of awareness of the value and need for animal source foods in the diets of children to promote growth and development and improve the health and pregnancy outcome of women.

- The dearth of practical participatory nutrition education from any source and lack of nutrition content in agricultural extension offerings contributes to low levels of awareness.

- Cultural barriers prevent inclusion of meat in diets of young children and women.

- Unequal intra-household distribution of meat often favors men at the expense of women and children.

- Families lack animal resources and need to consider use of small animals such as chickens, rabbits, fish, and non-traditional meat sources in their daily diets.

- Families have limited knowledge of appropriate technology for safe preservation and storage of meat to prevent spoilage and waste.

- Poverty and the need for cash drives the sale of animals and animal products, with little or none saved for household consumption or reinvestment of the income into animal foods for family consumption.

- Women lack influence on decision-making concerning the slaughter of animals for household consumption, sale of animals and their products, or the use of the income generated by these sales.

Community Level:

- There are few convenient markets with pricing structures and subsidies which favor the consumer in the purchase of animals and animal products.

- The lack of storage facilities and infrastructure to promote safe, sanitary, and regulated slaughtering and butchering creates further barriers to animal availability.

- Infrastructure is limited for training community nutritionists in collaboration with improved agricultural extension education concerning food and nutrition.

National and Multi-Country Regional Level:

- There are insufficient, or absent, policies and programs for school feeding for nursery and primary school children.

- Nutrition education has a low priority and thus receives insufficient resources and technical assistance in government ministries.

- The concept of micronutrient deficiencies used in policy formulation mainly emphasizes vitamin A and iodine deficiencies. However, crucial micronutrients such as iron, zinc, vitamin B_{12} and calcium, and the role of animal source foods in efficiently providing these micronutrients, have not been emphasized.

- Enabling policies to promote price supports and controls to increase availability and purchase of animal source foods, are insufficient.

Approach to the Problem

Given the analysis presented above, the following working hypothesis guides the proposed research and intervention activities: Increased availability of livestock and other small animals, together with appropriate agricultural extension and nutrition education, will increase utilization of animal source foods in the diets of children in poor rural communities. This improved diet quality will promote enhanced growth and cognitive development. The long-term project will therefore consist of two components:

1. A controlled intervention study among six to nine year old primary school children is planned to test if daily meat intake, compared to milk-enriched and energy-enriched diets, improves growth, cognitive function, and school performance when compared to a control group.

2. Community interventions in collaboration with NGOs are planned (a) to increase the availability of livestock and small animals to households; (b) to increase utilization of animal products in the diet through intensive nutrition education to alleviate micronutrient deficiencies and enhance children's

growth and development; (c) to enable households to increase their incomes; and (d) to enhance household food security. Universities and district level offices of the Ministries of Agriculture and of Health would also be collaborators.

This project would provide governments with policy options for promoting change and development in animal agriculture which will benefit smallholders. Specifically, these policy options will emphasize (1) reduction in costs of inputs and their increased effectiveness to make animal products available to a larger number of poor rural households; (2) linkage of animal production to improved human nutrition and promotion of growth and development in children; and (3) food-based rather than supplement-based solutions to micronutrient deficiencies.

Developmental Relevance

Improved health and nutritional status, improved growth and cognitive function and educational achievement are now viewed as human capital investments to promote economic development by the World Bank and Asian Development Bank in the Early Child Development Initiative. The controlled intervention study can take these latter research findings an important step forward. Positive results on the role of animal foods in supporting growth and cognitive function would be very powerful evidence in support of the need for increased availability and accessibility of poor families to livestock and other small animals and not just for production for large commercial markets.

Constraints

There are several constraints in the Problem Model which could limit community intervention impact and impede effectiveness. These include the following concerns:

1. At each site, the proposed interventions will rely to some degree on close collaboration with other agencies and programs to achieve program goals and objectives. The interventions assume the continued effective functioning of collaborating entities. However, over the five-year intervention period collaborating programs may experience a range of problems or difficulties which diminish their productivity and effectiveness. We will have no control over these constraining factors.

2. The interventions proposed here also assume some improvement in local health services. Since all the potential target communities experience high rates of infection, health services are necessary to reduce child illness. High burdens of infection can cancel out the positive effects of nutritional interventions.

3. The proposed interventions seek to influence traditional gender roles and beliefs around the management of household resources. Many of these beliefs and practices are deeply rooted in complex cultural traditions which may be resistant to short-term change. Therefore, only modest impact on these variables should be anticipated.

4. Through dissemination of findings, the interventions will hopefully

contribute to appropriate policy changes. However, experience suggests that national policies are often slow to change in response to research findings, and, in turn, reach peripheral local areas.

Assessment Team Process and Progress

Team Building

Initial contact was made with potential assessment team members, largely drawn from the attendees at the East Africa SRCRSP Livestock workshop held in Entebbe in January 1996 plus previous colleagues with whom the Principal Investigators worked with in Kenya and Uganda. The level of interest and potential involvement, expertise, and contributions were discussed via e-mail and FAX. Potential collaborating institutions, co-investigators and consultants were contacted both in East Africa and the USA and written concurrences of interest obtained. The two Assessment Team (AT) Workshops and the Participatory Rapid Rural Assessments (PRRAs) helped to create cohesiveness among team members of disparate professional and geographic backgrounds.

The workshop and field assessments provided opportunities to determine which AT members and other participants were seriously committed to participating in the long-term project and could supply the needed expertise. Spontaneously, in-country multi-disciplinary teams were formed to carry out the PRRAs, one in Uganda and one in Kenya. In Ethiopia a team continues to work with FARM Africa on a crop-based micronutrient intervention project. Because formative and baseline studies were carried out in 1996 and 1997, recent detailed background information was available without additional fieldwork.

Assessment Team Workshops

Assessment team members and other invited participants and consultants attended two workshops, one in late January 1997 in Nairobi at the Kenya Agriculture Research Institute (KARI) headquarters and one in Entebbe, Uganda on May 14 and 15, co-sponsored by ASARECA. The workshops played a key role in team building, as well as forging a common vision of the problem, the determinants, the needed research, and the approaches to community interventions. At both workshops, the majority of participants attended both workshops and were from Ethiopia, Kenya and Uganda. Three to four University of California scientists and a Pennsylvania State University consultant were present. The workshops were highly participatory with working groups concentrating on various aspects of the problem, research, and interventions. The workshop process helped foster and develop a sense of "ownership" of the project among the participating scientists, institutions, and agencies and hopefully will promote sustainability.

An Eastern Africa regional focus was emphasized at the workshops by providing opportunities for the sharing of experiences with common problems across national boundaries. Commonalities and differences in the causation of micronutrient malnutrition and poor diet quality problems and their potential solutions were compared.

Workshop I: Nairobi — Jan. 28 and 29, 1997: At this initial Assessment Team Workshop in Nairobi at KARI headquarters, there was substantial representation from Kenya, and less from Uganda and Ethiopia. Also attending a portion of the meeting were several investigators from the SRCRSP Kenya Dual Purpose Goat Assessment Team. The goal of the first workshop was to define and delineate the problem model, and initiate discussions concerning the content and scope of the long term proposal; primarily the controlled intervention study and the community interventions in three countries.

Also planned at this workshop were two Participatory Rapid Rural Appraisals (PRRAs) at potential research and intervention sites in Uganda and Kenya. Because of recently completed formative and baseline surveys in the proposed intervention sites in Ethiopia, a review of these comprehensive reports was to be conducted in lieu of new community studies. The background information requirements and gaps in information were identified. Assessment Team members, both in Eastern Africa and at the University of California (Los Angeles and Davis), volunteered to review relevant literature, documents, and report on specific topics with written assignments due prior to the second workshop. A consultative team was constituted from both Africa and the USA, based on recommendations from the universities, regional agencies such as Winrock International, and the International Livestock Research Institute (ILRI). The areas of background information to be gathered across countries were:

- The extent of micronutrient deficiencies in Eastern Africa
- The contribution of animal source foods to diet quality improvement
- Animal production by smallholder farmers
- Farming systems to support small animal production, care and maintenance
- Controlled intervention studies to improve micronutrient deficiencies
- Bioavailability assessment of diets for iron and zinc and food-based interventions for micronutrient improvement
- Socio-economic and policy issues
- Agricultural extension — content of services, coverage
- Gender issues in animal agriculture and household decision-making

Activities of non-governmental organizations (NGOs) involved in livestock and other animal dissemination efforts, production, management

Workshop II: Entebbe — May 14 and 15, 1997: The second Assessment Team Workshop was held in Entebbe on May 14 and 15 and was co-sponsored by ASARECA. There was an excellent turnout, with greater representation from Ethiopia and Uganda than at the first workshop. Because of time and budget constraints and because contacts in Tanzania were not in place early enough, there are no plans for inclusion of Tanzania at this time. However, Tanzania could be considered in the future as a possible intervention site.

The AT members who were involved in the Rapid Rural Appraisals reported on their findings in Uganda and Kenya. The Ethiopian groups reported on the recent surveys and formative research in the potential intervention area. Numerous focus groups and group meetings with key informants were conducted with frank and clear enunciation by participants of perceived problems and priorities for assistance. The second workshop covered the following topics:

- Finalization of the Problem Model, and goals and objectives for the long-term project
- Discussion of proposed components for the long-term project which included controlled intervention study (schoolers), community interventions, identification of relevant policy issues, and training and education needs
- Sharing of timetables and proposal requirements
- Institutional collaborations and individual co-investigators
- Project management mechanisms
- Multi-nation regional considerations

Two half days were spent in "breakout groups" which convened by content areas for the full proposal, with each country represented as far as possible. Each group made an oral report and produced a write-up of the main issues and recommendations. The "breakout groups" covered the following areas:

- On-farm animal production, management and care, and community selection of animal mix
- Gender issues in agriculture such as household decision making, income generation, animal ownership and intra-household food distribution
- Extension education: content, training, upgrading
- Policy identification and analysis of existing policies and future policy considerations
- Impact assessment including: (1) nutritional — diet, growth and nutritional status; (2) cognitive function; (3) socio-economic impact; and (4) food security
- NGO approaches to community intervention and programs
- Food processing and preservation of animal source foods (meat)

Participatory Rapid Rural Appraisals

The PRRAs were conducted during the interval between the two Assessment Team Workshops. Write-ups and dissemination of the findings were completed in May, prior to the second workshop. The PRRAs consisted of focus groups, small meetings, formal and informal, interviews, first-hand observations, small-scale household surveys, and interviews with locally active governmental and non-governmental organizations, all of which provided valuable information. The PRRAs offered valuable and useful insights into how the communities prioritize their problems and barriers and view possible solutions to their difficulties. These insights provide critical guidelines for development of appropriate interventions. Working as a multidisciplinary problem-oriented team was not only extremely educational and stimulating for the team members, but allowed a comprehensive and holistic approach to planning community interventions to increase the availability of farm animals for diet quality improvement and income generation. The PRRA has already provided an interactive collaboration between animal agriculture and human nutrition disciplines.

A consistent problem found across sites is the need for cash and income generation. It was consistently reported that meat was a rare item in the diet and that there were no widespread cultural barriers about feeding meat to children and pregnant women. However there tended to be inequality in the intra-household distribution of meat, favoring the men. The desire and need for cash seemed to drive the sale of animal products, at the expense of the family's diet quality.

All sites reported the shortage and even total absence of agricultural extension workers and the dearth of basic extension services. All sites stated that their flocks of chickens were being decimated because of the lack of available Newcastle vaccination for their flocks. Also it seemed consistent and clear in all the sites that goats would not be regularly slaughtered to supply the family with frequent meat. Cows or goats would be useful for milk production and only occasionally meat, but smaller animals such as chickens or rabbits could be slaughtered several times a week to "put meat on the table." People said they needed more goats in the household if milk is to be both consumed by the household and sold for income. Farmers were aware that the introduction of cross breeds or improved goats can increase milk production and income from milk sales. Rabbits would be acceptable in Kenya and Uganda, but not in the Muslim area of Ethiopia. The desire for more range chickens was universal if vaccination would be available and affordable.

It emerged that lack of women's decision-making powers, animal ownership, and control of income creates barriers to animal resource development. In some cases, women expressed concern over potential increased time demands for animal care and for growing more fodder as the number of household animals increases. This could be a problem unless assistance for women is provided.

Thus the PRRAs furnished important information for the development of demand-driven interventions. Also they provided information on the dietary patterns, beliefs about the value of animal products, and the actual use of meat in the diet. The rapid appraisals identified many of the constraints on ownership and care of animals in households. It also emerged that primary health care and basic sanitation were lacking in some of the sites, leading to high illness and parasitism prevalence. The latter health problems can cancel out any gains in nutrition improvement.

In Kenya the PRRA team was led by Dr. Patterson Semenye, farming systems to support animal ownership and management. His team included: Dr. Helen Ommeh, socio-economic and policy issues; Dr. Jane Alumira, agricultural extension education and services; Ms. Charity Kabutha, gender issues in agriculture and socio-economic arena; and Dr. F. Peter Wandera, animal production and breeding. Nutrition status and diet areas were covered by Rosemary Ngaruru, the District Nutritionist. Extensive data and information were obtained from the Kenya Nutrition CRSP studies conducted in the general area.

Primary schools were visited and invited to help in the planning of the controlled intervention study of school children. School visits were made to observe the classes and check on the timing of the snack and lunch breaks. The controlled intervention study would be carried out in the upper area and the community intervention in the lower zone of Embu and Mbere Districts at a later time.

In Uganda the PRRA was carried out by the Child Health Development Center team under Dr. Jessica Jitta, a physician, and Ms. Imelda Zimbe and Louise Sserunjogi, nutritionists, with input from Drs. Muyeya and Makuru of Heifer Project International, Dr. C. Laker, an agriculturalist, and Dr. C. Ebong, an animal scientist. Two sub-counties in Mukono District were studied: Bbaale, a semi-pastoral area in the north and Fakimura, a subsistence agricultural sub-county in the south of the district.

For Ethiopia two recent and comprehensive studies were carried out by FARM Africa and the ICRW Micronutrient Project, under the direction of Dr. Zewdie Wolde-Gebriel, a senior nutritionist, and Mr. Haptemariam Kassa, a development and agricultural economist from Alemaya University interested in food security, health, agriculture and nutrition. In addition to a baseline survey of food, agriculture, health, and nutritional status, particularly for Vitamin A deficiency, anemia, and stunting, formative research was carried out in reference to micronutrient deficiency and community suggested interventions.

Site Visits

Some of the UCLA team carried out brief field visits in the three countries to supplement the PRRA information on the potential target communities, to gain a first hand impression, and to validate key findings. Also, possible collaborating institutions and agencies were visited. The sites included Mukono District in Uganda, Eastern Hararghe in Ethiopia, and Embu and Mbere Districts in Kenya.

Uganda

Mukono District was visited with one of the nutritionists who carried out the PRRA. We visited two sub-counties, meeting briefly with leaders of farmers' groups and women's groups. We also met with two key staff people at the Uganda Heifer Project International (HPI), our potential partners in the community intervention effort. The visit was invaluable in confirming some of the PRRA findings, especially that the partly privatized agricultural extension services have been beyond the reach of farmers because of the very high fees charged by the extension workers for on-farm visits. Thus, basic agricultural extension services and education are virtually unavailable to most farmers. Also, cash is apparently in such short supply that food crops are sold for cash which is then used to purchase food for the household. Meat and fish are rarely purchased.

People expressed an interest in upgrading their local goats for both meat and milk production, as well as increasing their herd size. Great interest was expressed in increasing flocks of range chickens, if services such as vaccination against Newcastle disease were forthcoming. Rabbit-raising for food would be acceptable. One of the

AT members at Makerere University (Kiwuwa) is a renowned expert on rabbit production and wishes to collaborate in an effort to promote the raising of rabbits for improving the quality and micronutrient content of the diet. It was confirmed by people with whom we met, that wild pigs and monkeys were destroying the food crops. The Office of Forests and Wildlife has been repeatedly contacted by representatives of the area for control of these pests. Wild pigs are occasionally hunted for food and are a valued source of meat.

Contact was made with the USAID Uganda Mission. However, a Ugandan Agricultural Officer attended the workshop, to represent the chief agricultural officer J. Dunn who was unable to attend.

Ethiopia

The FARM Africa office in Addis Ababa arranged a trip to the potential field site in Eastern Hararghe, one of the sites of the Dairy Goat Development Project and a USAID supported crop-based micronutrient improvement project. Vitamin A and anemia are widespread in this region.

Also, we visited the International Livestock Research Institute (ILRI) headquarters to discuss collaboration with ILRI, specifically with Dr. Barry Shapiro, an agricultural economist. At all project intervention sites, we intend to measure economic impact of animal ownership on households and food security. ILRI agreed to oversee this aspect of the work pending official written approval.

Alemaya University of Agriculture in Harar was also visited. This University was established with the support of USAID and US Agricultural Universities and maintains some excellent resources including goat and chicken breeding facilities, a field nutritionist, and a USAID funded program under Winrock International for the retraining and upgrading of agricultural extension workers.

USAID was visited and a good reception was given to us by Mr. Berny Smith of the Office of Food and Humanitarian Assistance. The office is now changing its focus to development and food security and works mainly with NGOs with Title II funds. The local mission would consider funding for an NGO-associated research and/or intervention effort and encouraged our group to apply for funding at a future date.

Kenya

Lastly, a trip to Embu and Mbere Districts in Kenya was made to visit some of the primary schools and the District Education Officer, and to contact former field staff trained in food intake, nutritional status assessment, and cognitive testing. The visit sought to confirm the schools' interest in working on the controlled intervention study. Also, the district nutritionist and the community nutritionist who participated in the PRRA discussed details of some of the existing nutrition programs in the area.

The Integrated Small Livestock Project (ISLP) of the Ministry of Agriculture (in partnership with GTZ), is the main agency operating in Embu District at present which focuses on upgrading of goats and other animals and their distribution to farmers. The plan is to collaborate with this agency. Also, the possibility of introducing the Kenya Dual Purpose Goat (KDPG) into the area for purposes of crossbreeding is being considered. Rabbit-raising has been ongoing on a small scale and has great promise for expansion with rabbits supplied by ISLP. Range chickens are popular and flocks could be greatly expanded, if vaccination protection against Newcastle disease were provided.

Plan International, an NGO involved with nutrition improvement, community development and income generation through micro-enterprises, is very interested in collaborating with our project's community intervention activities in the drier areas of Embu and Mbere District. Extremely active women's groups and fairly well-developed agricultural extension services are additional advantages in these districts.

In Nairobi, KARI and the University of Nairobi Dept. of Food Science and Technology, with their Applied Nutrition Program and expertise in the production of processed weaning foods, would collaborate with the project. There has been a long-standing relationship between this latter program and UCLA.

The USAID Agriculture officer at the Kenyan Mission (Mr. Weller) was visited for a second time and he continues to be supportive of this project. While in Entebbe, we met briefly with the REDSO officials Dennis McCarthy and Keith Brown, who were meeting with ASARECA.

Activities Not Conducted

1. *More complete regionalization*: Originally, it was hoped that a Tanzanian site would be included in the long-term project. Because of funding constraints and the lack of direct contacts and previous affiliations in Tanzania, it was decided not to include a Tanzanian site visit at this time. Such a site would be considered for the future, should the opportunity and funding allow.

2. *Greater sharing of materials with the assessment team and rapid feedback:* This has not worked as well and as frequently as hoped. Faxing has often been problematic with disruptions in telephone service and discontinuous FAX service. Although e-mail has functioned better than the FAX, there have been problems down-loading attachments. During the heavy rains, telephone lines have been disrupted, and thus e-mail has not always functioned. Also, not everyone has e-mail. Courier air service is quite efficient but is costly.

3. *Use of the Kenya Dual Purpose Goats (KDPG):* We found that these animals have not been generally available for cross-breeding with local goats. We will still try to incorporate these animals into the intervention, perhaps in Embu, and hopefully we will be able to collaborate at one of the sites in Uganda with the KDPG regionalization and dissemination effort under Dr. C. Valdivia.

4. *Leveraging of funding:* There is inadequate lead time to realistically leverage new funding for our proposed project and have it in hand by the end of July, 1997. However, we are submitting

proposals for funding consideration. We did get a strong indication from the Office of Food and Humanitarian Food Assistance (Title II Program) in the USAID Mission in Ethiopia that they have funds for NGO-associated research and interventions relevant to their mission of food security, diet improvement, and development. Because our planned collaboration is with FARM Africa, the chances for Mission funding are promising.

"Retrospective leveraging" is another source of leveraged funding (to be treated in greater detail in the Final Proposal). There are a number of research, training, and intervention programs related to the proposed project. These already-funded activities have established the groundwork, created the infrastructure, and provided a source of trained personnel and excellent background information to build upon, representing a sizable contribution to the proposed project.

Future Activities

The proposed project will consist of two primary components: 1) A controlled intervention trial to determine the effect of increased intake of animal source foods on physical growth, cognitive development, and school performance in school age children (6-9 yr.) in Embu District, Kenya; and 2) community interventions in three countries to examine how increased availability of livestock and other small animals to households impacts diet quality, child growth and cognitive development, food security, the health of child-bearing women, and household economic status.

Controlled Intervention Study

An unprecedented opportunity to demonstrate whether or not the inclusion of animal products in the diet is advantageous for young children's cognitive and physical development is available to us in Embu, Kenya, the site of the former Kenya Nutrition Collaborative Research Support Program (NCRSP) originally funded by USAID. In Embu, the school-aged children obtained over 75% of their energy intake from maize and beans, one percent from milk (35 grams per day), and less than one percent from meat (11 grams per day) (9). When investigating the developmental and behavioral outcomes of these children, it was clear that the children who consumed the least animal products performed the least well on cognitive tests measuring verbal comprehension and perceptual abilities, were the least attentive in the classroom (2) were less active and less happy, and showed the least leadership behavior on the playground (10). Thus, evidence from previous observational studies with school-aged children in Embu strongly suggests a link between the intake of animal products and optimal cognitive, social and physical development.

We propose to carry out a controlled intervention study with school children in Embu in order to verify our observational findings that animal products play a key role in the optimal development of children in this setting. In order to clarify the effects of micronutrient intake on child development, we propose a nutritional intervention with four levels: a meat intervention, a milk intervention, an energy intervention and a control condition with no intervention. In the energy intervention, the supplement will be comprised of maize, legumes and vegetables that already make up 75% of the diet for this age group. Extra oil will be added to equalize the energy intake in all but the control group. It is of interest to compare the meat and milk interventions to a straight energy intervention because it is important to know whether the same benefits can be gained by merely increasing the energy intake of children. Intervention studies in other countries have found developmental improvements due primarily to increased energy intake (11), so it is important to clarify both the role of energy and the role of micronutrients for optimal development. A milk intervention and meat intervention will be carried out at separate schools because of the findings that milk is low in iron and zinc and that calcium and casein can interfere with the uptake of iron and zinc. Thus supplying both meat and milk to one group of children may make it more difficult to isolate benefits of micronutrients in the meat, and even cancel out the benefits of iron and zinc. There is also an erroneous widespread belief that milk is equivalent to meat nutritionally and can be used in lieu of meat.

Embu District is uniquely suited to this intervention because of available previously trained local people to help carry out the assessments. Second, the methodology and validity for measuring food intake, anthropometry, cognitive abilities and behavior has been worked out in this population, making the implementation of these measurements considerably less burdensome than if we were assessing this locale for the first time. Thus, experimental intervention would add to what has already been accomplished by potentially allowing us to attribute behavioral and cognitive improvement to animal products in the diet which is not possible from the previously complex naturalistic observational study.

Intervention Design

Sample: The sample will be composed of all children enrolled in the first standard (grade) in one of twelve elementary school classrooms in three sublocations of the Embu District. We expect an overall sample of about 480 children.

Design: Each of the 12 elementary schools will be randomly assigned to one of four interventions: meat supplement, milk supplement, energy supplement, or control intervention. All standard one classrooms at a given school will be assigned to one level of the intervention.

Year One: During the first term, before the intervention begins, children will be observed on the school playground and in the classroom, and their cognitive, reading, writing, and mathematics abilities will be tested. In addition, blood samples will be collected for hematological and biochemical analysis and examination for physical signs of deficiency and anthropometry carried out. The feeding intervention will then commence at the beginning of the second term (March) and through the third term. All observations will be repeated in the middle and at the end of the intervention year.

Year Two: During the second year, the children from the first year will continue to be supplemented in their standard two classrooms, and the first standard classrooms will also receive the same intervention. Behavioral observations, cognitive testing and anthropometric measurements will be continued quarterly throughout the second year.

Intervention: The three supplement groups will receive "breakfast" at school every morning. The control group will participate in all of the cognitive, social and physical measurements, but will not receive a school meal. The basic food for all three intervention groups will be *githeri*, a vegetable stew composed of maize, beans, fat and some greens. For the meat intervention, finely chopped meat (2-3 oz/child) will be added to the stew. The goa tmilk intervention group will receive an additional 8 ounce of milk. The energy intervention will receive *githeri* with extra oil to increase the number of calories. The energy available to the children in all three experimental conditions will be equivalent. Children will be observed during breakfast and uneaten foods will be carefully weighed and food intake outside of school will be quantitatively measured for two contiguous days every other month. These methods were fully validated in previous studies.

Behavioral and Cognitive Assessments: The classroom and playground assessments will be based on observations using time sampling to derive estimates of child activity and social interaction on the playground, and activity and attentiveness in the classroom. The Ravens Progressive Matrices and the Verbal Meaning Test, an assessment designed for Eastern Africa will be used. The reliability and validity of these measures have been demonstrated in our previous research (2, 3, 10). An assessment of short-term memory/attention will also be administered because of reports of the impact of iron deficiency on these parameters (13).

Anthropometry and Laboratory Measures: Children's height will be measured quarterly and weight and illness experience, monthly. Pre and post-intervention assessments will be made of anemia, iron stores (ferritin), zinc, and vitamin B_{12} which are necessary to determine the association between food intake, physiological changes, and children's improvement in cognitive and behavioral scores.

Family Measures: Because family background has an important effect on children's behavioral and cognitive competence, the socio-economic level of the family and the parent's reading and writing literacy will be evaluated by previously designed tests using graded materials.

Data Analysis: Our primary hypothesis of interest, that meat will show the most beneficial effects on child outcomes, will be tested using repeated measures ANOVA procedures. As in most intervention studies, the design of the study is completely hierarchical, with schools nested in treatment levels, and students nested in schools. We will also be able to determine whether there were differences between schools within each treatment conditions. Random assignment of schools to treatment condition will help ensure that the quality of school will be equally distributed among the four different treatment conditions.

By carrying out an intervention at schools, we have the added benefits of 1) learning how to implement a sustainable school feeding program in a rural African setting and 2) reaching the majority of children in the community.

Community Interventions

The goal of the community interventions is to enable households to increase their animal ownership and to ensure that their animal resources are utilized to improve diet quality, food security, and household economic status. Although the specific interventions will eventually be designed with community and NGO participation, the programs will focus on four objectives: 1) improving the quantity and quality of animal resources controlled by households; 2) increasing utilization of animal source foods in daily diets through consumption of household animals and their products or through increased purchases of animal source foods using income derived from sales of household animals and their products; 3) increasing income generation from animals and their products; and 4) improving household food security.

Sites:
The proposed intervention sites are in Eastern Hararghe, Ethiopia, a mid-highland area; Mukono District, Uganda, a partial pastoral area and subsistence farming area; and the lower semi-arid area of Embu and Mbere Districts in Kenya.

Increase Availability of Animals

The proposed program will collaborate closely with NGOs and other organizations which work with poor households in the target communities to obtain, maintain, and improve livestock and small animal husbandry. The interventions will be developed and implemented together with potential NGO and other collaborators such as FARM Africa in Ethiopia, Heifer Project International in Uganda, and/or PLAN International and GTZ, the German aid group in Kenya. The University of Nairobi, Makerere University in Uganda, Alemaya University in Ethiopia, and District Ministries of Agriculture and of Health will all provide technical advice for the development and implementation of the animal interventions. Groups such as KARI and NARO will be involved with technical assistance and policy.

While specific interventions will be tailored to meet the challenges of each target community, several intervention approaches being developed by collaborating agencies will be emphasized. These include: 1) promotion of micro-credit lending groups to support household purchase and management of animals; 2) introduction and promotion of small animals (alone or jointly with livestock) such as rabbits (except in Ethiopia), free-range chickens, and fish to help "put meat on the table" several times a week; 3) training of small holder farmers (men and women) in the care, management and upgrading of their animals; and 4) promotion of livestock such as goats for milk and meat production for sale and home consumption.

Increase Utilization of Animal Source Foods through Participatory Nutrition Education

Household ownership of animals in no way guarantees that they will be used to directly enhance diet quality, or that income derived from their sale will be used to purchase animal products for family consumption. Moreover, there is no assurance that children or women will receive animal source foods even if these foods are available in the household. A number of barriers to utilization were identified in the Problem Model above. Participatory nutrition education programs will therefore be tailored to the specific needs in the disparate target communities to address each of these barriers. While each target community will present unique challenges and circumstances for the interventions, the following approaches will be used in each area:

1) Education activities will seek to raise the awareness of policy makers, agricultural extension workers, health workers, and parents that animal foods, particularly meat, are needed in the diet to promote health, growth and development of children and to enhance school performance and work output. Animal food consumption is needed to complement intake of fruits, cereals, and vegetables to supply the key micronutrients in adequate amounts.

2) Project activities will attempt to modify or replace cultural beliefs and patterns of intra-household food allocation that prevent women and young children from including meat in their diets.

3) Education activities will help families, both male and female heads of households, to manage and balance household animal resources in a manner which optimizes the use of these resources in family diets while maximizing cash income generation from sale of animal products.

4) Consumer education provided to households will emphasize how to optimally and wisely use cash for the purchase of healthful and affordable food for the vulnerable members of the family.

5) Participatory education activities will promote the joint development and demonstration of recipes by community women and extension workers which incorporate meat into dishes for children.

6) In each community appropriate technologies to better preserve and store meat will be developed. For example, packets of dried meat-containing weaning mixes produced on a community level could serve as a "value-added" income generation activity by women similar to the Nutribusiness project of the Applied Nutrition Program at the University of Nairobi, our potential collaborator.

7) The education activities will include messages on immunizations, basic sanitation and safe water use, and family planning since nutrition gains can be canceled out by infection, parasites, and large numbers of children .

Gender Issues

The gender issues of concern are animal ownership and management, household decision-making, control of income, intrahousehold food distribution, time demands for animal care, and need for training in animal care and animal health. These concerns and issues will be incorporated into all interventions.

Impact Evaluation

In order to measure the impact of the community interventions a quasi-experimental pre and post-test non-equivalent control group design will be implemented. A control community will be matched for each intervention site to better evaluate the changes related to the interventions. Pretest surveys in treatment and control areas will generate baseline information and data on key impact measures (see objective matrix). Formative research and program monitoring activities will allow analysis of household and community participation in the programs. Post-test surveys in treatment and control areas will provide data on key measures for analysis of program impact. Also, within households, changes will be measured before and after the intervention.

Impact will be measured in five areas through use of the pre and post-intervention surveys. The following attributes will be operationalized as outcome variables for evaluation of program impact: 1) Household ownership of livestock and small animals (number, type, quality, health of animals owned, resources to support animals, demands on time of household members, contribution to food supply); 2) diet quality; 3) cognitive function in 6-36 month old children; 4) growth and nutritional status in children, including measures for anemia (hemoglobin, hematocrit); 5) household food security (availability, accessibility, stability, quantity and quality of household food); and 6) household economy (resource endowment, crop and livestock production, labor allocation to animal care, income controlled by women, commercialization of dairy/meat production, expenditures on non-food items). Economic performance indicators are being operationalized by Dr. B. Shapiro of the International Livestock Research Institute (ILRI) and will be adapted for each of the three intervention sites.

Linkages to Policy-Oriented Organizations

Linkages to multi-country regional organizations such as ILRI, ASARECA and Winrock International, government ministries such as Ministries of Planning, Agriculture and Health, and parastatal organizations such as NARO, KARI, and IFPRI will promote consideration of policy issues. Because of the multi-disciplinary approach and nature of the team there would be, for the first time, a firm linkage and integration of animal production with improvement of human nutrition and health as well as household economic improvement on the policy, planning and implementation level.

Another important policy issue deals with food-based approaches to combat micronutrient deficiencies. In the long-run, these are more sustainable than pharmaceutical and supplement-based approaches. Fortification, which is most promising on a national level, particularly with iodine and iron, does not necessarily answer the needs of many rural subsistence families that live outside the commercial sector. They will not have access to commercially processed fortified foods.

Training Education Needs

Education and training needs in nutrition, extension education, child development and other areas will be assessed. Support for training will range from short in-service courses to graduate education. It is already obvious that training of professionals is needed in nutrition education and in community-level animal health.

Relevance of Project to USA

This project has great relevance to the USA. We have children on suboptimal diets who are iron and zinc deficient. These children exhibit anemia, poor growth and suboptimal learning in school and in the preschool years and do not attend to intellectual tasks as well as non-anemic and non-deficient children. With the recent cutbacks in public nutrition support services, the USA needs to develop means of intervening at a household and school level to insure that children are receiving the appropriate diets to promote their development and learning in school.

With the negative press toward "red meat" intake in the USA, self-imposed restrictions in women of reproductive age and imposed on young children can, actually be detrimental. Vitamin B_{12} and iron are vital to the development and function of the CNS and prevention of anemia. Zinc deficiency is found among poor children and among children on strict vegetarian diets. The functional consequences of these deficiencies are just now being appreciated in the USA.

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PRESENTATIONS

Neumann, C.G. "Nutritional requirements and nutritional deficiencies of low income sub-Saharan women" to be presented Aug. 10-16, 1997 in a symposium: Sustainable nutritional security for sub-Saharan African women subsistence farmers. XIII. International Conference of Agricultural Economists (IAAE), "Food Security,Diversification and Resource Management: Refocusing the Role of Agriculture?

Neumann, C.G., Murphy, S.A. and N.O. Bwibo. "Improved micronutrient status and growth and development of Kenyan children through increased intake of animal products." Paper to be presented Oct. 12-16, 1997 at The 8th International Congress of World Federation of Public Health Association: Health in Transition-Opportunities and Challenges. Arusha, Tanzania.

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Objective 1: To promote community involvement and participation in the analysis and development of solutions to the problem of low animal source food consumption in order to provide guidance for development of a "demand driven" intervention strategy

Outputs	Impacts	End Users	Actions/Activities Taken to Accomplish Outputs	Team Members	Completion Time
Community Needs Assessment (identification of community felt needs and perceptions):	**Provided baseline information (indicated below) which shaped the development of appropriate and feasible community-based interventions:**				
1. Priority concerns and perceived barriers to enhancing household animal husbandry 1.2 Children's diets and the role of animal source foods 1.3 Factors and constraints which limit animal source foods in the diet 1.4 Suggestions by community for interventions and services needed to improve diet quality	1. Community concerns as basis for joint planning and priority setting with researchers and community 1.2 Community perceptions and concerns around child nutritional problems and dietary quality 1.3 Community view of the role of animals in the household and willingness to use them for dietary improvement 1.4 Basis for developing intervention approaches consistent with community felt needs	Farmers-men and women, MOA and MOH, extension staffs, NGOs, Women's groups, Men's groups, School teachers, Assessment Team, Community leaders	In the communities identified as potential project sites, the following activities and actions have been carried out: PRRAs by multidisciplinary teams Focus groups Spontaneous small group and individual interviews with key informants Systematic surveys of small household samples (n = 50-60 per community) Sharing of findings with community for feedback to project staff	Animal scientists, Farming systems expert, Nutritionist, Economist, NGO, Extension specialist, Gender specialist,	4-5 months Feb. - May 199

Objective 1 continued.

1.5 What community members believe they can do for themselves	1.5 Communities' willingness to mobilize and help themselves in order to promote self-reliance and sustainability		Feedback of the community to the Assessment Team Feedback to several NGOs and governmental officials Written assessment reports shared with communities and NGOs		
2. External resources and assistance required for potential interventions	2. Definition of external assistance needed to conduct interventions	MOA extension, MOH extension, NGOs, Regional organizations, Foreign Aid Missions	Search for leveraged support through various contacts with appropriate agencies		

Developmental Relevance: The promotion of community participation in problem definition and development of potential solutions is vital to the sustainability of interventions and programs. These are essential elements to long-term community development.

Objective 2: To assess the availability of livestock and other small animals to rural small-holder households and their utilization for household consumption.

Outputs	**Impacts**	**End Users**	**Actions/Activities Taken to Accomplish Outputs**	**Team Members**	**Time to Completion**
Animal Availability to Households: 1. Community profile of numbers, types and quality of livestock (LS) and other small animals (SA) owned by households 1.2 Community profile of resource adequacy to procure and care for LS and SA. Constraints and problems were identified	1. Provided baseline data for planning and targeting of interventions to increase animal ownership by families 1.2 Provided data necessary to focus interventions on enhancement of local inputs and services to support increased animal ownership	MOA, NGOs, Assessment Team, Extension workers, Farmers	Reviewed relevant literature, research and reports Conducted participatory rapid rural appraisals (PRRAs) which included focus groups, group and individual interviews Conducted limited household surveys, KAPs (health knowledge, attitudes, and practices surveys) and site visits to potential project sites	Animal scientists, Farm management specialist, Nutritionist, Economist/policy, Gender specialist	4-5 months If full proposal is funded, assessment will continue in greater detail and breadth.
3. Information about availability, content, quality, and contact frequency with agricultural extension animal education and services	3. Provided basis for development of training interventions to expand quantity and quality of extension education and services.	(Special focus) . MOA, Extension workers, NGOs	Interviewed the Ministry of Agriculture extension workers Interviewed farmers -- both men and women	(Special focus) Agricultural extension expert, Nutritionist,	

Objective 2 continued.

Utilization of Animals: 1. Assessment of community-level knowledge concerning the importance of animal foods in the diets of children and women	1. Contributed baseline information for the development of participatory nutrition education intervention approaches and messages	Extension educators, Assessment Team, Women and men, School teachers,	Women's and men's focus groups Household interviews Interviews of extension and health workers KAP surveys	(Special focus) Nutritionist, Extension expert	same as above
2. Assessment of sales of household animal products to generate cash 2.1 Assessment of women's contributions to household decision-making regarding consumption or sale of animal products and use of income earned	2. Provided baseline data for development of interventions to promote improved management of animal resources for consumption and sale 2.1 Provided baseline data for development of intervention approaches to enhance women's household decision-making and control of income in order to improve household diet	Farmers -- both men and women	Rapid site visits an d rapid market surveys Household interviews Women's and men's focus groups, separately and combined	(Special focus) Gender specialist, Extension expert, Nutritionist	
3. Identification of barriers including socio-cultural, religious and economic to consumption of animal source foods by women and children	3. Contributed information for development of education strategies to eliminate barriers to the utilization of animal source foods in the diet.	Extension workers, Nutritionist, Assessment Team, Families	Focus groups, men and women, separately and combined Household interviews KAP surveys	Nutritionist, Extension expert, Anthropologist (consultant) Gender specialist	

Objective 2 continued.

4. Assessment of local attitudes toward use of various small animal species as food sources	4. Provided baseline data to develop interventions which promote utilization of a wider range of affordable animals. These would require less costly inputs than LS for consumption and are compatible with frequent use.	Above list, plus MOA	same as above	Nutritionist, Animal scientist, Extension expert, Farm management expert	
5. Information on content of diet in regard to animal source foods for children -- type, frequency 5.1. Information on prevalence of nutrient deficiencies in communities	5. Provided data to establish priorities for nutrition interventions and develop content of nutrition education messages	Above list, plus MOH	Review of research and survey reports Small sample surveys of food intake and nutritional status	Nutritionist , Extension expert, Animal scientist	

Developmental Relevance: Improving the physical and mental development of children is a capital investment in the future development of a nation and its leaders.

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Team Member Name	Affiliation	Role/Discipline	Nationality/Residence
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Early Warning System for Monitoring Livestock Nutrition and Health for Food Security of Humans in East Africa

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Narrative Summary

Famine / food security in East Africa has been a chronic issue for decades given the weather variation, expansion of human populations, political instability and changing land use/tenure policy in the region. For pastoralists in the region, survival of their livestock herds determines food security. Donor organizations have developed several efforts to provide monitoring programs to help identify emerging problems in the region. USAID's Famine Early Warning System (FEWS) and the "Crisis Mitigation for Livestock Systems" project of the Greater Horn of Africa program are examples of such activities. To respond to uncertainty, pastoralists in East Africa must be afforded timely, higher quality information about their local trends and options.

A series of spatially explicit analytical tools and direct animal monitoring systems, developed in the Texas Agricultural Experiment Station at Texas (TALES) A&M University, will be tested in a manner that allows integration of information into the existing monitoring and advisement infrastructure of East Africa. These tests will provide information on the nutritional status of livestock and projected trends in forage supply to pastoralists, in-country policy makers, NGO staff, international donors and global monitoring organizations. The plan is to make maximum use of communication infrastructures ranging from highly visual postings and written reports to distributed CD-ROMs and electronic information via the Internet. The Center for Natural Resource Information Technology at TAMU has an excellent capacity to package and deliver information of which the Integrated Information Management Lab (IIML) and Ranching Systems Group (RSG) are key members. The goal is to allow more informed decisions as to actions required to reduce famine risk and initiate famine relief efforts in a more timely, cost-effective manner.

The geo-referenced monitoring and analysis system will be integrated with the coordinating organization for agricultural research in East Africa, Association for Srengthening Agricultural Research in Eastern and Central Africa (ASARECA) and the International Livestock Research Institute (ILRI) to help identify mitigation research topics. Efforts will also be made to integrate the nutritional monitoring program with ICRAF's GIS/ remote sensing lab to investigate the potential of NDVI pattern analysis statistically related to NIRS fecal profiles to predict emerging diet quality in non-sampled regions.

A series of in-country core monitoring and analysis teams in Eritrea, Ethiopia, Kenya, Tanzania and Uganda have been formed during the assessment phase to design criteria to establish a classification system of the region which allows spatial representation of "effective environments" using the existing weather, terrain, soil, human and livestock datasets in the GIS-based Spatial Characterization Tool (SCT) allowing a 5x5 km grid assessment of the region. IIML at the TAES-Blackland Research Center has assembled the foundation datasets for East Africa and will be responsible for expanding those datasets as additional information is generated within the project. Monitoring locations and specific sites within the effective environments will be assigned to representative effective environments selected for the region, based on region-specific panels of in-country experts (professionals and lay people). Location and site selection criteria will be based on the nature of infrastructure available to the team and level of funding from USAID and other leveraged sources. Sampling routes and actual sites within each location will be based on: 1) accessibility via motorcycle, truck or car, 2) diversity of institutions such as schools, clinics or NGO activities, 3) existing government infrastructure such as universities, extension offices and experiment stations, 4) degree of pastoral grass root organizations and 5) personal security risk of the samplers.

Nutritional well-being of free-ranging livestock will be assessed through fecal profiling via near infrared reflectance spectroscopy (NIRS), which was shown viable for East Africa in the assessment phase of this Livestock CRSP. Each sampling site will be geo-referenced with an inexpensive GPS unit to allow integration of the fecal profile information with SCT, livestock population surveys and continuous 10-day weather datasets from the FEWS program. These inputs provide a foundation dataset for a meta-modeling system involving a multiple species plant growth/livestock production model (PHYGROW), a livestock nutrition model (NUTBAL), a mixed farming crop model (APEX) and a modified El Nino/Southern Oscillation (ENSO) driven model calibrated for East Africa. The ENSO component of the project is the only module not developed to date. The other analytical components are in place, only requiring development of data-transfer mechanisms between modeling environments, i.e., creation of a meta-modeling infrastructure. The resulting analysis will be linked with a series of information sources for pastoralists, in-country decision makers and appropriate donor and NGO organizations. Careful analysis of communication networks among pastoralists, government decision makers and global assistance organizations will be required to assure the information flows have maximum value.

Problem Model

Over $4 billion has been spent by donors in the Greater Horn of Africa between 1985 and 1992. In the late 1980s an estimated 71 million people, or 46 percent of the region's population, were chronically food insecure. Food insecurity reduces peoples' quality of life and fosters the social, political, environmental and economic instability associated with recurring crises. The limitations of the natural environment in East Africa place certain constraints on improving food security. The chances of drought occurring in parts of the Greater Horn have increased from a probability of one in six years to one in three years for areas affected. Repeated occurrences of drought and high variability in precipitation have reduced the ability of many smallholders to maintain their assets or to respond when conditions are good. Inter-annual variability of rainfall has been increasing in the crescent from Kenya to Sudan, including parts of Ethiopia and Tanzania. Other natural disasters such as pest infestations and periodic flooding destroy area-specific production levels. Analysis of these factors supports arguments for a more effective early warning system in the region, especially as it affects livestock throughout the pastoral and mixed farming region of East Africa. We must think crisis prevention and early warning.

Such programs as USAID's Famine Early Warning System (FEWS) and the Crisis Mitigation project within the Greater Horn of Africa program have been designed to focus attention on problems of monitoring emerging famine situations and gaining a better understanding of the causes of famine, addressing:

"...the broader causes of disaster by placing a strategic focus on sustainable development while responding to the existing and impending crises in the region....new ways of thinking, new ways of acting and new institutions should be adopted and supported by all partners in the region."

The "relief-to-development continuum" approach of the Greater Horn of Africa program has been promoted as the critical framework for this region, considering simultaneous integration of short-term emergency responses and long-term development assistance. Development of multi-scale early warning systems are a primary objective within this regional program.

Crisis prevention involves the ability to foresee and the means to prevent, prepare for and mitigate or resolve crisis and conflict. Effective prevention requires monitoring and analytical capacity at the regional, national and local levels, as well as the ability and will to respond to warning signs of all kinds. In this proposal, this refers to livestock nutritional well-being and forage imbalance in a timely and appropriate manner.

Of the current set of information generated by donor-based monitoring programs such as the FEWS program, many of the problems besetting livestock have occurred because the human eye, no matter the level of personal experience, can only partially detect the trends in declining nutritional balance. The proposed NIRS fecal profiling system, developed for the US by the Ranching Systems Group at Texas A&M University (TAMU), when coupled with spatially referenced information and analysis, can add a new dimension to the various monitoring programs in East Africa. When properly set up and implemented, the system will provide an additional 6-8 weeks lead time on the current early warning systems in East Africa. When linked with the suite of simulation models on animal nutrition developed by the Center for Natural Resource Information Technology at TAMU (i.e. grazingland forage growth/ hydrology and mixed farming crop models), analytical capacity of existing early warning infrastructures would fill a much needed niche. This niche would bridge "stand off" monitoring and on-ground surveys of emerging effects of drought and other stress conditions associated with pastoralist in East Africa.

The Assessment proposal sought to establish the necessary methodologies, analytical tools, organization and infrastructures to develop an early warning system for livestock nutrition and health as an integral part of existing early warning systems for drought and famine in East Africa, particularly FEWS, NOAH-USGS, FAO-GIEWS, AFRNET, ASARECA and the Greater Horn of Africa programs. There are a series of technologies developed by TAMUS that provide critical support to the effort including the advanced GIS-based Spatial Characterization Tool (SCT), the NIRS-NUTBAL nutritional management system, APEX cropping systems model and PHYGROW multi-species growth/hydrology grazingland systems model. Each of the analytical tools are unique to the Assessment Team assembled at Texas A&M University. Dr. Corbett is the co-developer of SCT. Dr. Jerry Stuth is the coordinator for the Ranching Systems Group that developed the fecal NIRS profiling system, the NUTBAL nutritional decision support system and the PHYGROW grazinglands modeling environment. Dr. Jimmy Williams along with Dr. Paul Dyke are developers of the APEX farming systems model and will be leading the effort to integrate ENSO information where possible. When the analytical capacity of this research group is blended with the robust network of professionals and organizations connected to these scientists in East Africa, the formula for successful development and implementation of a livestock early warning system emerges for the region. Our challenge is to demonstrate the usability of these technologies in East Africa and that a critical mass of personnel and institutions can be organized in a manner that provides timely and high-quality information on trends in the well-being of livestock. Also, to ensure that this information can reach all levels of decision making from the pastoralists to national policy makers and international assistance/monitoring organizations.

Assessment Team Process and Progress

Overview of Proposed Activities

Over the nine month assessment period the Livestock Early Warning Systems (LEWS) Assessment Team (AT) planned to focus on: (1) formation of a core assessment team representative of the five target countries in East Africa, (2) clarification of tool integration for analyses, (3) seeking alliances with critical organizations involved in early warning systems in East Africa, (4) development of a broader group of in-country AT members representing NAR, IAR, Universities and NGOs, (5) establishing in-country pilot sites for fecal sampling protocol testing, (6) pursuing partnering relationships with US corporations, (7) planning and conducting a workshop involving a larger group of people for the AT to develop the full CRSP proposal, (8) establishing partnerships with international donor/monitoring and NGO organizations and (9) conducting analyses of the meta-modeling and monitoring tools proposed for a livestock early warning system. The primary issue, during the assessment period, was to ascertain how to solicit cooperation from key organizations and individuals in the region to assist in devising a field sampling protocol, identify logistical constraints on the success of the project and test our analytical tools relative to existing capacity within the region.

During the initial phase of the assessment grant, our efforts would need to focus on understanding the critical issues of tool integration and potential methodology of classifying regional landscapes for monitoring purposes. The key concept was how to construct a monitoring protocol that could provide timely, yet accurate information on the nutritional status of livestock and the likely trends in forage supply over 30-day monitoring intervals.

An initial planning meeting was targeted for January 1997 in Nairobi, Kenya where a group of in-country specialists from several East African countries could be briefed on the objectives of the proposal by the TAMUS AT members, solicit inputs as to improved design of the study and determine how best to set up a network of sampling sites that would allow testing of fecal profiling technology. The group would also be instrumental in identifying critical players throughout the region that would be invited to a larger planning workshop at Addis Ababa, Ethiopia in March 1997. We planned to rely heavily on the newly formed East African Livestock Research Network, part of ASARECA, to identify key professionals within East Africa to participate in the final planning phase of the assessment project.

The period of January through April is the traditional period where a transition occurs between the dry and wet seasons throughout most of East Africa. We felt that it would be critical to the assessment process to establish pilot sites throughout Eritrea, Ethiopia, Kenya, Tanzania and Uganda where livestock populations could be selected and evaluated and fecal samples collected during this period to test the proposed protocol for site selection and sampling and demonstrate that the fecal profiling technology could detect season shifts in diet quality. During this same period, we planned to refine the NIRS fecal profiling equations with an extensive African dataset provided by ILRI. Once the dry season had been broken and rains caused greening of the forage, the fecal samples were collected and shipped to the Grazingland Animal Nutrition Lab at TAMU to determine the geographical robustness of the Africanized NIRS equation and functionality of the NUTBAL nutritional management system for predicting protein and energy balance of the animals assessed.

To maintain the spatial contest of the processes, our plans were to have the pilot site coordinators use GPS units to geo-reference fecal samples, livestock herd assessment and photographs of the animals and the vegetation conditions. This information would be organized into foundation datasets within the framework of the SCT system to demonstrate how information, with both time and space tags, could be packaged and delivered to the various information sources from the local to international level.

Integral to the evaluation process would be the testing of the NUTBAL, PHYGROW and APEX simulation models. Given that southern Kenya was in the middle of a crop failure, the plan called for the use of weather and soils data from the National Rangeland Research Center at Kiboko, Kenya, to exercise the models to determine if the proposed methodology for vegetation characterization, livestock population estimates and crop planting information could predict the observed shortfalls in forage supply and failure of the corn crops of that region. The results of this model testing effort would also be integrated into the SCT foundation data set and subjected to systems integration analysis by the team of analysts in the Integrated Information Management Laboratory and the Ranching Systems Group at Texas A&M University.

These findings would serve as the final refinements that would be made to the proposed livestock early warning system project protocol.

Throughout the assessment process we felt it would be important to study how the existing early warning systems were organized and how best we could interject our information into existing infrastructures. We planned to gain a greater understanding of the USAID FEWS project and the various donor-sponsored, regional drought monitoring projects in East Africa. FEWS provides the infrastructure to link to global weather data and analysis as well as on-ground monitoring of the human activities such as markets, health and movement. Identification of these organizations would be critical to define our role in the overall scheme of assistance in the region and level of capacity building required to allow in-country monitoring infrastructures to emerge after the initiation of the Global Livestock CRSP funds.

Finally, we targeted some specific international donor organizations to develop collaborative efforts such as ILRI, Rockefeller Foundation, DANIDA and ICRAF in the region as well as NGOs such as FARM Africa, PENHA and World Vision. Linkages with the various international research organizations are critical to provide the nucleus of infrastructure for the more advanced technologies in the early phases of the project and assist with building robust sampling routes within each country, in the case of the NGOs.

Leveraging of funds is essential to the success of the project, and we planned to involve corporate entities that would have a vested interest in LEWS. Particularly, we felt the manufacturer, FOSS NIRSystems (formerly Perstrop Corp.), would be a key player in equipping the proposed five national NIRS laboratories to handle the fecal profiling system. We planned to obtain letters of commitment from FOSS to allow purchase of the machines at much reduced prices. We also targeted Dell Computers Inc. to help provide computing capacity to the sampling locations throughout East Africa, including placement in extension offices, clinics and schools. Dell has targeted East Africa as a market development area for its line of personal computers. To help reduce transportation costs for sampling the regions, we planned to ask major motorcycle manufacturers to help donate or provide motorcycles at low cost to the program.

US support for the project was critical as well, and we planned to work with the Grazinglands Technology Institute within the USDA-Natural Resource Conservation Service to help establish a mirror program in the US through their agency to assure that technology developed within LEWS would be directly transferable back to the US. This would assure that the technologies developed in East Africa would help build an infrastructure which directly benefited US livestock producers.

Progress

TAMUS has organized a team representing in-country national organizations for Ethiopia, Eritrea, Kenya, Tanzania and Uganda which convened at the campus of the International Livestock Research Institute (ILRI) in Nairobi, Kenya for an initial planning meeting January 27-31, 1997. The group of individuals that came to the meeting represented a rich cross section of the network of in-country professionals who had previously worked with the TAMUS component of the assessment team. The purpose of the meeting was to work on communication coordination between national organizations, select sites for demonstrating the feasibility of the fecal profiling technology, develop a fecal/animal characterization sampling protocol, assemble data needs for simulation models, review spatial data development for the SCT databases and identify the most appropriate professionals and organizations to participate in development of the proposal for a livestock early warning system in East Africa.

Based on consensus of the AT members at the Nairobi meeting, a larger group of in-country specialists was convened at ILRI-Addis Ababa, Ethiopia on March 17-21, 1997 to provide additional input into the larger LEWS CRSP proposal. The following number of individuals attended the meeting: Tanzania 3, Kenya 4, Uganda 2, Ethiopia 6, Eritrea 1 and TAMUS 3. Other AT members that did not attend include: Tanzania 2, Kenya 2, and TAMUS 2. Working on the full proposal were middle level scientists representing the lead national agricultural research (NAR) organization in each country and at least one in-country university scientist representing the animal and rangeland management disciplines (see Team Composition in latter section). ILRI and ICRAF scientists (animal, range, animal health, breeding, and GIS) stationed in Kenya and Ethiopia were also integral AT members.

At the Addis Ababa meeting, the LEWS AT agreed to the following objectives for the full proposal:

- To integrate the state of the art early warning tools into a cohesive methodology.

- To demonstrate that the technology is appropriate and usable in East Africa.
- To develop a network of cooperators and partners to implement a full scale Early Warning Livestock and Food Security program for East Africa.
- After reviewing the objectives of the CRSP program and the general goal of the livestock early warning system, each of the tools to be used in the project was reviewed.

NIRS/NUTBAL - Nutritional Management System

Near infrared reflectance spectroscopy (NIRS) is used to predict dietary CP (crude protein) and DOM (digestible organic matter) via fecal scans while NUTBAL models the nutrient balance of livestock (cattle, sheep, and goats). Both technologies have been adopted by USDA in the US as the primary tools for assessment of livestock well-being on grazinglands. The Grazingland Animal Nutrition Laboratory (http://cnrit.tamu.edu/ganlab) at Texas A&M University provides a national service to livestock producers which allows rapid responses (two-days from receipt to reports) to assess the protein and energy status of free-ranging livestock and make recommendations on nutrient mediation where needed. Currently, GAN Lab serves 960 ranchers in 28 states and recently signed a contract with USDA to expand services to over 500 additional ranchers covering 42 states as part of the national program on assessment of animal well-being in US as part of the Global Change Program in USDA. Approximately 7000 samples per year are currently processed through the lab.

When fully operational, we expect that each lab to be established in LEWS can easily handle the caseload generated and support further R&D efforts in NIRS profiling of grazingland animal nutrition, nutritional ecology, parasite loading and, in the case of Uganda, free-roaming chickens.

SCT- Spatial Characterization Tool

The existing geo-referenced database of Africa will be used as the foundation database to derive the appropriate sampling frame and map early warning output. The Spatial Characterization Tool, SCT, (an early 'Beta' release of the tool was called the Data Exploration Tool or DET) is a GIS application tool which draws on a suite of gridded environmental data, point data, and vector based information. Access to the gridded data enables the rapid construction of simple "empirical" quantifications of conditions at a site or in a zone. The tool can also create transects which can demonstrate the change in a variable over space. This first version of the tool was designed to provide scientists and other decision makers with a mechanism to easily access environmental information for characterizing target areas. The first order environmental determinant, climate, is supplemented with additional data in the SCT including population density, soils attributes (pH, depth, AWC, etc.), and topography.

Climate is generally considered a first order "determinant" of ecosystem character, with edaphic factors second, followed by human intervention and other natural disturbances. This hierarchical determination of the constraints on ecosystem structure has been captured by the SCT to provide a useful model for characterizing agricultural and natural environments. Beginning with the climate surfaces for monthly minimum and maximum temperature, mean precipitation, and mean potential evapo-transpiration, the foundation is prepared for a scale-integrated, dynamic mechanism for supporting natural resource management and agricultural research and development efforts.

With spatially interpolated climate data, digital elevation models, and low resolution soils and socioeconomic data in place, characterization commences with simple models used to differentiate growing season and off-season characteristics. These "climate analog" models serve to describe the initial domain or target area for a range of analytical steps, from sample design in diagnostic surveys and field trials to the identification of the number of people affected for institutional priority setting. Detailed socioeconomic, farming systems, soils, biodiversity, etc. information are much more difficult to acquire, however, become more critical in refining domains as issues such as resource access, land tenure, cropping system and labor availability, thereby becoming the focus of the analysis. These characteristics dominate at higher resolutions.

Once a zone of similarity is found, a suite of statistical tools in SCT can be used to further characterize the selected zone. In other words, a zone identified as having a seasonal precipitation total of 500-800 mm with maximum temperatures never exceeding 32 degrees C, could then be broken down into its component sub-zones using additional data on, for example, soils, minimum temperatures, categories of precipitation, regions affected by specific policies, infrastructure (e.g., road density, access to markets) or even animal production strategies reflecting land tenure (as evidenced by the results of fecal profiles collected over time). Or, for example, these additional data might be used to stratify your target zone using a specific set of conditions (e.g., human population density, precipitation, crop density) for a subsequent survey.

The SCT represents a synthesizing tool drawing from a plethora of international efforts at database construction. For example, the climate data originated from individual institutions and scientists who have historically collected and organized meteorological data. These data were then combined to create datasets of long-term climatic normals. These long-term normals were processed by yet another group (e.g., CRES, Australia National University, for Africa) to produce the climatic surfaces. We used these surfaces, and created other surfaces following similar methods, to model the growing season and extracted characteristics of the season. Other international organizations contributed the soils data, the socioeconomic data, as well as the terrain and population information. The SCT represents then, a multi-scale, multi-disciplinary integrating tool, providing capabilities for decision makers (from scientists to managers) to efficiently tap the potential arising from the integration of spatial data which creates spatial information.

To date, the SCT has been used by CGIAR scientists, tropical disease researchers, the WMO, the Seeds of Hope II project, the disaster mitigation arm of USAID, the Rockefeller Foundation, and the World Resource Institute, Chemonics Inc., just to name a few of the clients. Their feedback continues to motivate development of the database, improved analytic capabilities, and the user-friendly interface / access tools.

Plant Growth/Yield/Hydrology Simulation Models

PHYGROW is a hydrologic based model used to predict grazingland forage production. The system simulates complex forage resources (point or spatially referenced), functions with multiple species of grazing animals and grazing landscapes/species, selectively. The model is sensitive to animal selectivity of plant species and translates these processes into animal production in terms of stocking rates. It is an object-oriented design model and, therefore, is well suited to link efficiently to the other models in the toolbox incorporating the range and forage components of the impact analysis. An expanded explanation of the system can be found on the Internet at: http://cnrit.tamu.edu/rsg/phygrow.

APEX is a crop/agro-forestry model needed to predict crop yield. The system allows depiction of multi-crop simulations such as in agro-forestry or intercropping situations. APEX is built on the foundation of the EPIC model for which the IIML has been instrumental in refining and supporting over the years.

Weather data input into both the PHYGROW and APEX models will be supplemented by analyses generated from the global ENSO programs, which is a model of the likely probability of rainfall using analysis of ocean temperatures gridded across the Pacific and Indian Ocean tropical zone. The El Nino and Southern Oscillation (ENSO) effects will be used as a mechanism to improve our short-range weather projections for the models.

Results of Livestock Monitoring Protocol

The LEWS AT spent considerable time reviewing results of the sampling protocol conducted over the five months in East Africa. The following are the main observations of this group:

- A need to spend considerable time informing village elders and local administrators about the fecal sampling prior to initiating the monitoring program. A small diagrammatic pamphlet to provide information on the program and its benefits to farmers and pastoralists is suggested.
- The method of sampling watering points was concluded to be more problematic than initially envisioned and we recommended sampling household bomas where possible.
- The herd characterization process (species, breeds, weight by class) should be separated from fecal collection activity.

a. The assistance from livestock owners was evidenced by the difficulties encountered in counting, aging, and estimating animal weights (by class) of herds. This activity needed to be accomplished less frequently (than the fecal sampling) and should be undertaken with local extension officers or veterinarians working with pastoralists.

b. The age stratification categories on the forms can be reduced.

c. Initial sampling requires a team of at least three for photography, form filling, and the fecal sampling.

d. Time is critical and we need to develop a more efficient on-site sampling mechanism to allow more sites to be visited. During the workshop, the group recognized two types of sample sites: "core" sites which are sampled by a LEWS team member and "participant" sites which may involve schools, markets, clinics, extension and partner efforts (e.g., NGOs and other UN, FAO, etc. programs).

Development of a Spatial Sampling Framework

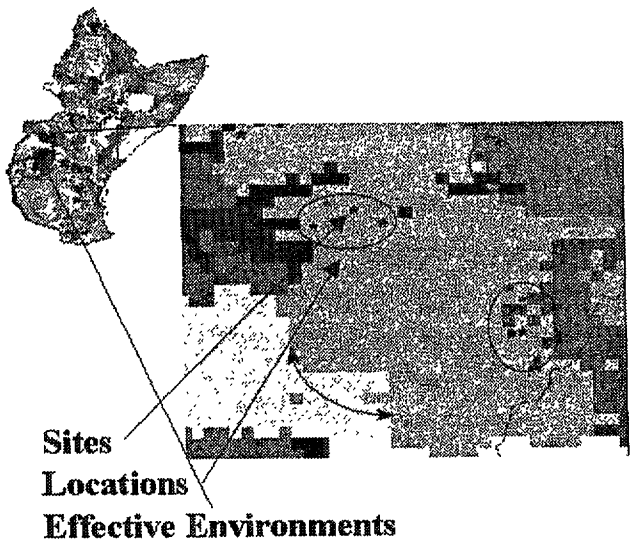
To better understand the sample stratification process and the sampling protocol, the AT traveled to Debre Zeit and viewed one of the pilot sample areas. The group used this opportunity to discuss the process, definitions and premises which will be used to build the spatial sample frame. The following concepts emerged from that discussion:

Baseline data can be thought of as data for which there is no lower level of disaggregation. For example, a raw Landsat image constitutes baseline data as would a digital rendition of a soils map or a set of point data describing meteorological or climatological conditions.

Foundation data are databases for which some value-added process has taken place and which have been placed into an integrated package. A classified Landsat image is foundation data as are climate surfaces (climate surfaces being the product of an interpolation of point data). Foundation data also extend into the realm of output from simulation models. For example, a crop or pasture simulation model ran on every grid cell in a foundation database produces additional foundation databases for each simulation run. A key characteristic of foundation data is the placement of these value-added databases into an integrated package.

Effective environment (EE) is a term used to describe a specific, classified result of an analysis of foundation data. Effective environments are "homogeneous." For example, over all of East Africa, we used a cluster analysis of growing season variables to group similar climates, then combined these 200 zones with a US Soil Taxonomy based classification of soils. The resultant 800 plus "effective environments" reflect the highest resolution of target environments — created from continuous data surfaces — that we are able to produce for this region. These three concepts (baseline,

Figure 1: Effective Environments and the Sample Frame.



Sites were where fecal samples were collected. Locations were identified, by local teams, as areas within an effective environment (EE) which represented local variation within the EE. The EE's were created in an iterative process connecting the local team's knowledge to the spatially continuous databases.

foundation, and effective environment) also share one vitally important characteristic: these are databases that are spatially coherent or (to use a term from the GIS literature) these databases are, by definition, topologically correct.

Using these effective environments in combination with local expert opinion (knowledge of locally significant micro-environments) and infrastructure information, *locations* are selected by the LEWS AT for rigorous fecal sampling at regular time intervals (Figure 1). The term "location" also signifies the package of information we will input into our simulation models from *sites* which have fecal samples collected. Locations offer empirical confirmation of our simulation results.

One final term is necessary. *Niche* describes the simulation units inside an effective environment not directly monitored. A niche can be topologically correct but it does not need to be. For example, after the creation of an effective environment database structured on growing season climatology, we can create niches to subdivide the effective environment by topographic position (hill top, valley bottom), soil, and even management practices. We would not know where in the effective environment certain conditions exist, we may only know that 20% of the effective environment is a particular set of soils and management conditions or "virtual landscape types." Niches differ from locations only in that they are not connected directly to empirically sampled information.

The AT convened country groups to discuss how best to approach consensus building for:

- Criteria for deriving the effective environments.
- Appropriate sample site characterization variables.
- Organizational linkages for information flow in the livestock early warning system.

After considerable debate, there emerged a consensus on how to best approach an adequate sampling frame.

Step 1: A designated group of experts and core AT members will convene from each country to review the data elements in the SCT for that country. A set of criteria will be identified and a spatial analysis will result in the creation of effective environments for livestock.

Step 2: Once the effective environments have been established, a review of items like the following will be conducted to establish representative sample locations within each effective environment:

- Differences in production system
- Security / risk issues
- Accessibility (roads, phones, etc.)
- Existence of support infrastructure (people, facilities, vehicles)
- Presence of potential partner organizations (NGOs, universities, research centers, etc.)
- Vegetation degradation
- Disease risk
- Water availability / stability

Step 3: Selection of actual sampling sites within each sample location. These sites will likely be at household bomas, watering points, schools, stock routes, and/or markets as is appropriate.

Information Requirements

Considerable discussion followed as to what information was needed to be collected for each site, location and effective environment.

Effective Environments

Effective environments are the macro-scale regions derived from expert opinion and spatial databases. The resolution of the effective environments will be limited to the data resolution of our spatially contiguous databases.

Locations

Once locations are selected, they need to be further characterized by:

- Modal plant communities (species / functional group, deWitt relative yield values by species / functional group, tuning of plant growth attributes).
- Modal soil layer characteristics.
- Herd population structure (secondary data or heuristic data from local extension). We are linking with ILRI's Breed Characterization Project for complementary information.
- Modal crop information (species, variety, timing, etc.)
- Water supply and capacity information.

Sites

Fecal profile sites within each location require:

- Geo-referenced coordinates from GPS units.
- Type of production system.
- Percent of location represented by each site (e.g., some locations may be sufficiently homogeneous as to require one fecal sample to represent micro-scale conditions. Others will require more).
- Fecal sample by species.
- Assessment of body condition score by animal class (specific criteria to be determined by core LEWS CRSP group).

In addition, the following kinds of support information are projected to be useful: supplemental feed characteristics, roughage fed and stored, vegetation greenness (using standardized photo strips), standing crop classifications, crops, disease incidence, mortality, livestock transfer rates, sales rates, etc.

Rapid Deployment Criteria/Methods

Weather data will be initially derived from the existing meteorological station network. However, we agreed that small rain gauge and max/min thermometers would be allocated on an "as needed" basis to assist in more robust characterization and future simulation investigations.

We will actively pursue use of gypsum soil moisture blocks as a mechanism to improve projections of models. Placement, monitoring, training, etc. for this data collection effort needs additional discussion with the core AT.

During the Addis meeting the AT members from each country constructed an information flowchart within the various governmental organizations which would lead to dissemination of the early warning information to critical entities for policy making. This exercise was a very positive learning process for the AT because it allowed each team member to appreciate the uniqueness of information flows in the various countries and the need to establish strong linkages between countries. The linkages with the ASARECA organization is critical to this process.

Assessment of Analytical Capacity

The AT visited the ILRI research center, at Debre Zeit, to review the livestock research program and assess their capacity to support science requirements of the LEWS. In particular, support is envisioned for the confirmation and calibration of the NIRS/NUTBAL nutritional management system. Debre Zeit would serve as the site for establishment and personnel training for the first in-country NIRS fecal profiling laboratory. This location was selected based on early commitments by ILRI and ease of transborder shipment of fecal samples via ILRI agreements with the Ethiopian government. FOSS NIRSystems has agreed to provide NIRSystems Model 5000 near infrared reflectance spectrophotometer at a much reduced rate to support establishment of these labs in each of the five LEWS countries. We plan to bring Ethiopian research and ILRI staff to GAN Lab for two month training sessions and work with FOSS NIRSystems to set up a system with REMOTE access to the machine for distance trouble shooting. NARO, in Uganda, via Dr. Ebong has committed to providing the second machine for that country. We will then review priorities for the next three locations, so as to see how funding is emerging within the LEWS project.

Timeline

Critical to the Addis meeting was the establishment of a proposed timeline for project activities, if and when funded. This first generation timeline is provided below, without modification from the Addis meeting. Along with the timeline, the AT outlined a set of major tasks that need to be performed during the course of the project:

Year 1:

- Acquire and calibrate a NIRS system for delivery to ILRI -Debre Zeit. An ILRI technician and, if funds permit, technicians from Uganda will travel to TAMU for two months training on NIRS procedures.
- Conduct country specific workshops to delineate effective environments, identify sample locations, and develop specific sites for fecal profile sampling.
- Establish linkages with appropriate policy organizations.
- Establish contacts and implement collection sites.
- Assemble necessary information to adapt NUTBAL model to East African conditions.
- Characterize locations by modal plant communities, soils, crops, etc.
- Develop methods for characterizing livestock populations.
- Plan core group meeting in May or August of 1998 to review progress (May preferred).
- Establish need and timing of organizational surveys.
- Produce Annual Report and CD-ROM.

Year 2:

- Implement full scale sampling scheme / design early warning information delivery system.
- Define conditions for rapid response teams.
- Seek linkages with disease / parasite monitoring project.
- Initiate crop monitoring protocol.
- Review funding status for second allocation of NIRS lab equipment.
- Assemble supporting data for PHYGROW, APEX, ENSO.
- Develop rapid response infrastructure.
- Establish school / clinic / market participant protocol for fecal sample collections.
- Conduct workshop on and investment in analytical capacity building.
- Initiate information flow for early warning when data starts flowing.
- Design graduate student capacity building program.
- Acquire NIRS system and conduct training for Uganda-NARO agreement.
- Produce Annual Report and CD-ROM.

Year 3:

- Improve / refine information reporting system.
- Identify other production systems, e.g. camels, equine, that could be incorporated into LEWS (Livestock Early Warning System).
- Review budget for potential purchase and establishment of third NIRS lab.
- Review sampling protocol.
- Expand graduate student training opportunities within project.
- Write proposal for next three years.
- Expand NIRS, GIS, analytical (including modeling) capacity with each participant country.
- Produce Annual Report and CD-ROM.

Years 4-6:

- Continue analytical capacity building.
- Expand graduate research programs.
- Develop spin-off research programs.
- Expand training in GIS, NIRS, and modeling.
- Develop alternative mitigation strategies for utilizing LEWS.
- Produce annual and final report and corresponding CD-ROMs.

Gender and Children Issues

The AT invited a social scientist from ILRI/IFPRI to discuss women and children issues relative to the proposed livestock early warning system. There are a number of serious gender and children issues which would be addressed as part of the LEWS. An example which illustrates this relationship is shown by the fact that, as drought sets in, men will move large stock to other regions leaving women and small children behind to care for small stock. In many cases, small stock are owned by women. Based on analysis by the social scientists, LEWS would allow the family to be more proactive in their decisions, allowing the women and children to have more time to respond to conditions and perhaps allow mitigation actions to be implemented to reduce the risk of famine. The proposed pilot program on involving school children in the monitoring process was well received by the sociologists interviewed while conducting the in-country assessment. We had AT members interview rural school teachers and assess their level of interest and feasibility to work with children to collect feces from their family bomas and learn about animal nutrition as a series of science modules. NGOs would be approached to help donate funds to purchase school supplies for the children as an incentive program for their participation. The AT agreed that the school program should be a series of pilot sites rather than a large scale effort.

Results from the Herd/Feces Characterizations

Most LEWS-AT members attending the January workshop collected fecal, livestock and weather data during January, February and March, 1997 (Kenya started in December), to provide foundation information to support the development of the final proposal. This in-country group of pilot site coordinators interacted with the full AT group at the Addis Ababa meeting to help refine the fecal/herd sampling process and discuss critical issues for establishing fecal/herd profiling sampling routes. Armed with these insights, an additional fecal/herd sampling was conducted in April after the dry season broke. Eritrea was added to the sampling protocol at that time, due to the participation of Dr. Berhane (Dean of Agriculture at University of Asmara) in the workshop. After the Addis meeting, all the fecal samples shipped to the USA (via SteriGenics International's irradiation facilities) were scanned via a near infrared reflectance spectrophotometer (NIRS) by the Grazingland Animal Nutrition Laboratory at Texas A&M. The results provided information on nutritional status of livestock at the 19 pilot sites established across the five countries.

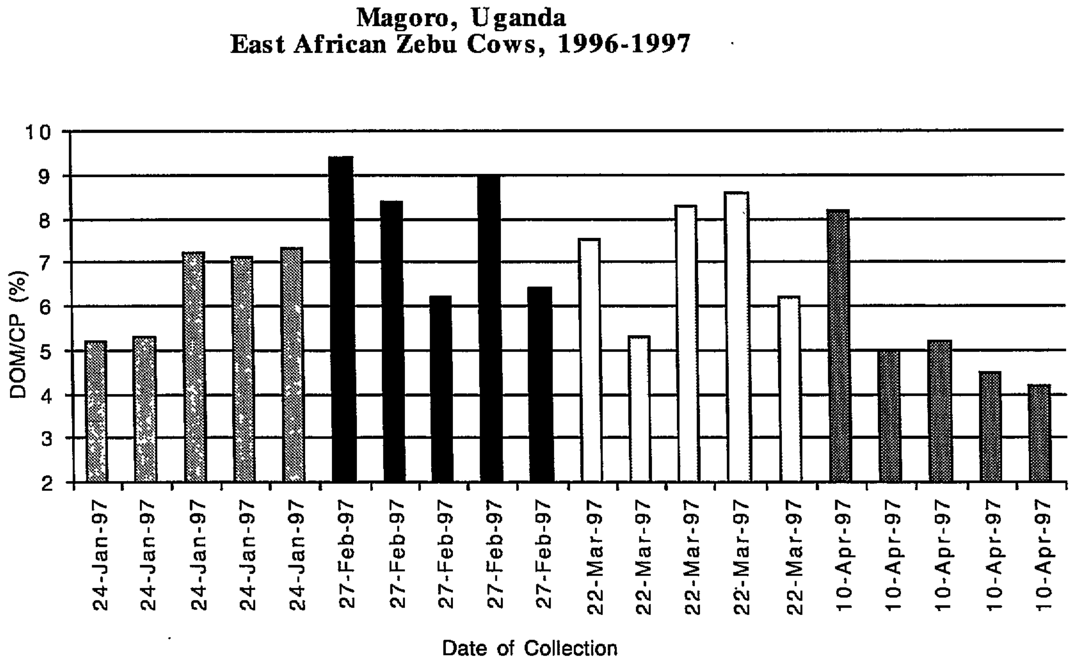
Weather information, vegetation data, soil descriptions and photographs of livestock and forage conditions (all geo-referenced) were integrated with the fecal NIRS derived estimates of dietary crude protein and digestible organic matter for input into the NUTBAL Nutritional Balance Analyzer to predict nutrient balance and gain status of the animals surveyed at the pilot sites. The nutritional values, nutrient balance and geo-referenced photographs were integrated into Spatial Characterization Tool (SCT) and placed on a CD-ROM to demonstrate how the information could be distributed to both internet-ready and non-internet computing facilities in East Africa.

Drs. Stuth and Corbett have been asked to present an overview of SCT and the LEWS project at the USAID-ASARECA sponsored "Crisis Mitigation in Livestock Systems" workshop, as part of the Greater Horn of Africa program meeting on July 6-10 in Naro Moru, Kenya. They will meet with key LEWS-AT members to review the livestock assessment results of the analysis and get last minute feedback on changes in project protocol.

Over 600 fecal samples were shipped to GAN Lab for analysis from the five countries. We found that the current US equation was very stable for predicting dietary crude protein (CP) and digestible organic matter (DOM) with most of the samples, except for some marsh areas in north central Uganda. We found the Africa-only NIRS equation to be less robust when predicting DOM concentration in the animal's diet. However, when we integrated the two datasets the spectral integrity of the NIRS equations was greatly improved resulting in less than 3% outliers from all the countries for both CP and DOM. Rockefeller Foundation is funding a Ph.D. student, Sarah Ossiya, to return to ILRI's Debre Zeit facilities, in Ethiopia, from September-December 1997 and run a series of validation trials on the combined USA-Africa NIRS fecal profiling equation. Ms. Ossiya is a Ph.D. candidate at Texas A&M University and will be an integral member of the LEWS-AT when she returns to NARO's Serere Research Center in Uganda. Rockefeller provides post-graduate funds to assist her research program when she graduates in December 1998, the start of Year 2 of the project.

When the herd survey forms were reviewed by the staff at GAN Lab and paired with the predicted CP and DOM values, inputs could be made in the NUTBAL nutritional balance analyzer decision support system to predict CP and NEm/NEg balance of the cattle, sheep and goats sampled throughout the multi-country pilot sites. Gain/loss of cattle were also predicted. Approximately 1200 case analyses were run on cattle and 600 cases on sheep and goats. A sample profile of Magoro, Uganda (*"Location"* site) is presented in Figure 2, representing five household bomas (or *"sites"*) sampled from January to April of 1997. We have found the DOM/CP ratio to be a good index to nutritional status of cattle in this survey. When the ratio is greater than 7, microbial activity is restricted and protein is deficient for the animal, resulting in weight loss. Maximum microbial efficiency occurs at a ratio of 4. In this location, the cattle in the first household in the graph were acquiring better diets than the other sites. However, when the rains occurred, the

Figure 2: NIRS fecal profile predictions of diets -- cattle grazing rangeland in Magoro, Uganda, from January 1991-April 1997 at five household bomas.



same household did not recover as quickly as the other four sites in this location. If the monitoring system had been fully implemented, a rapid deployment team member would have been dispatched to that area to determine if conditions warrant issuance of a warning report.

Based on feedback from the pilot site coordinators at the Addis meeting and our experience in interpreting inputs by the survey personnel, several problems emerged in design of the forms and training for the planned sampling system. The first lesson learned was that an information dissemination and discussion process needs to take place with local leaders in pastoral communities to explain the program and get them to help designate individual pastoralists or livestock congregation points to sample the herds. Where this did not occur, some local pastoralists reacted negatively to the fecal sampling process. However, where our teams worked with the local extension officer and village leaders, the fecal profiling was strongly supported by the pastoralists. Pastoralists that were selected for herd profiling were of great assistance in helping to provide information on their herds and picking up the fecal samples, which in turn allowed the sampling team to cover greater distances between bomas. We also ascertained what the pastoralists thought would be the best way to disseminate the information that resulted from the fecal analysis. They stressed the need to get information back if they were to participate in the collections. They felt that congregation points would be good locations to place the information, especially at large watering points, livestock markets, clinics, schools and extension offices. The information would need to be easy to understand and mitigation suggestions provided where appropriate. There will be a need to establish communication networks among the people at collection sites to enrich the information flow at the local level. We had particularly strong support for the idea of incorporating school children in the monitoring process, particularly if we devised mechanisms to interject science lessons on nutrition along with incentive systems for the kids and their teachers to participate in the program. All of our pilot site coordinators visited local rural schools and reported a positive response by the teachers. Reactions of NGO and PVO sampled, in the regions, indicated that they would be strong supporters of the school programs, if we integrate a two-way information flow on livestock nutrition and develop in-school science modules for the teachers.

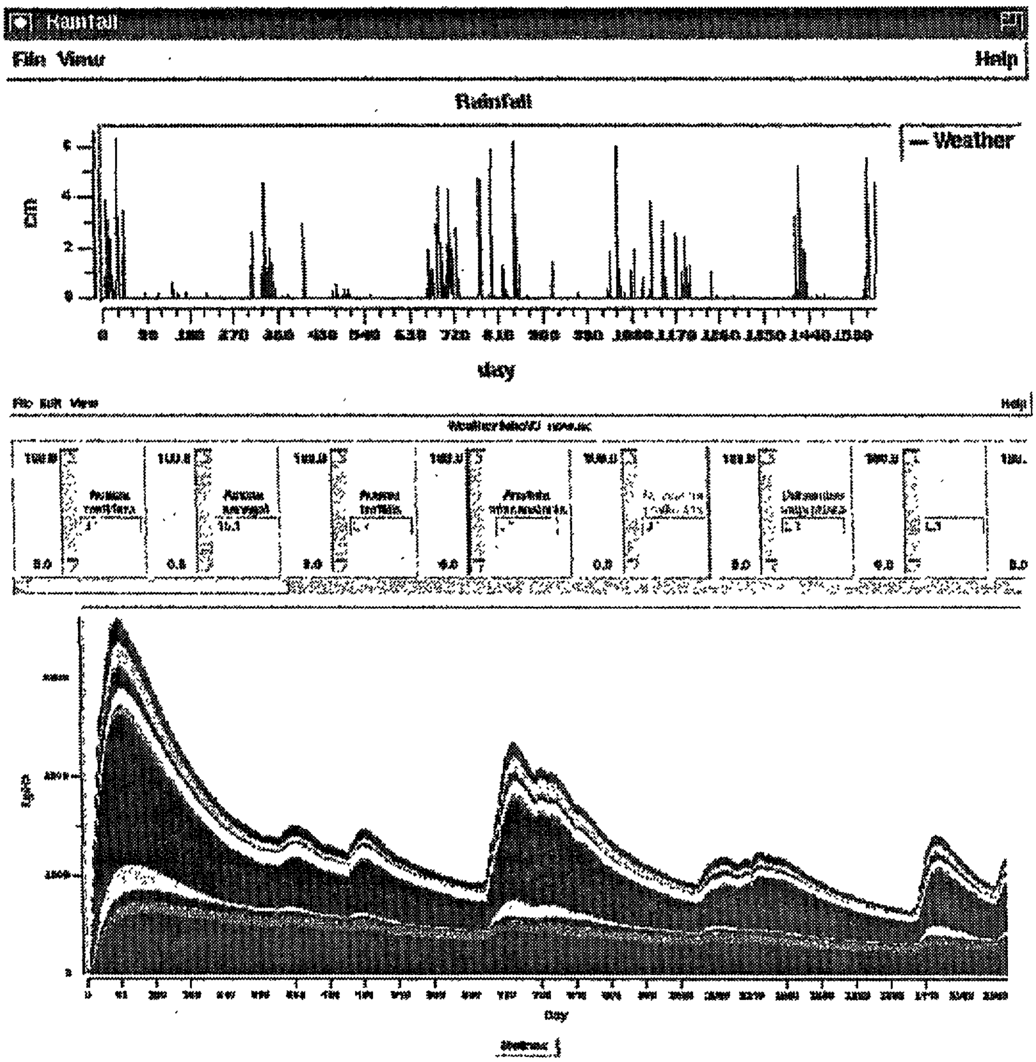
A major challenge will be communication of information to people living in areas not sampled, but located in similar effective environments. We plan to weave our information on trends in livestock well-being into existing communication networks among the pastoralists, government agencies, NGO and PVO. We will need to devise a combination of oral explanations of visual representations of livestock and forage trends for areas where literacy rates are critically low. ICRAF has agreed to link their pattern analysis of NDVI with the geo-referenced fecal analysis to help to determine if this technology can be integrated to predict diet quality in remote regions not sampled.

To test the feasibility of the simulation models, soils and weather data from the National Range Research Center in Kiboko, Kenya were input into the PHYGROW simulation model using the progressively dry years between 1993 to 1997 to demonstrate the emergence of drought and the ability of the model to detect change in forage supply under grazing. The site was chosen due to the extensive dataset on vegetation growth and animal nutrition developed by Dr. Stuth over the past 15 years. PHYGROW modeled the two dominant vegetation types in the region of Kiboko: 1) Acacia senegal savanna and 2) Commiphera woodland. In both cases, PHYGROW was highly responsive to the weather, soil and vegetation inputs, simulating many of the observed shortfalls in forage supply observed prior to and during the assessment process (Figure 3).

Leveraging Funds

Throughout the workshop and follow-up discussions, there was a concerted effort to identify sources of leveraging funds with other funding sources, including private industry and NGOs. We have commitments from FOSS NIRSystems (formerly Perstrop Corp.) to provide NIRSystems at a much reduced price, resulting in a savings of over $100,000 to the project if NIRS labs are developed in each of the five countries. The National Agricultural Research Organization of Uganda (NARO) has committed to purchasing a NIRS system and providing the necessary infrastructure during Year 2 of the proposed project as part of their DANIDA project on "Role of Animal Protein in Cognitive Learning of Children" with emphasis on supporting the livestock monitoring efforts. The commitment is valued at approximately $80,000. The GAN Lab team members have agreed to assist NARO in

Figure 3: PHYGROW - Kiboko, Kenya - Acacia Senegal, Savanna Rainfall and Grazed Standing Crop Jan 93-April 97.



development of a diet quality prediction equation for free-ranging chickens via fecal/egg profiling as part of the partnering process within the early warning CRSP. This will assist them in meeting their commitments to the DANIDA project focusing on identifying ways of improving the survival and productivity of chickens in pastoral and mixed farming conditions. These free-ranging chickens are a critical source of protein for children during their formative years where learning is most impacted by adequacy of protein intake. An excellent dialogue was initiated between the TAMUS AT members and Dr. Michael Smalley, ILRI, in conjunction with USAID's CGIAR-University Research Initiative, to identify a series of training needs within the CRSP proposal that would be of mutual benefit to both organizations objectives. These topics included:

- Prediction of parasite loading in cattle, sheep and goats via NIRS fecal analysis.
- Prediction of amino acid/tannin relationships in multipurpose trees via fecal scans with NIRS technology.

- Prediction of microbial protein, metabolizable protein and metabolizable energy via fecal scans with NIRS technology.
- Validation, calibration and refinement of the NUTBAL nutrition model for East African conditions.
- Use of NIRS technology to contrast breedtypes' nutrient acquisition under varying grazingland conditions.
- Impact of landscape degradation on nutritional stability of livestock via NIRS fecal profiling technology.
- Use of GIS to establish livestock population profiles and dynamics.
- Use of GIS to spatially reference incidence of internal parasite and emerging chronic health problems in relation to derived effective environments and nutritional regimes via the SCT system.
- Use of GIS and the SCT system to determine the relationship between microclimate and composition of livestock species and breedtypes.
- Investigation of the use of NIRS technology to predict dry matter intake of free-ranging livestock.
- Development of a NIRS prediction equation to profile nutrient values of compost for small dairy systems in East Africa.
- Use of NIRS technology to predict grain feeding levels in diets of small dairy systems in East Africa.
- Use of NIRS to derive seasonal transitional decay rates of nutritional decline in livestock diets grazing of major range types in East Africa.

ILRI accepted the 13 proposed training topics and will consider them during their internal deliberations and prioritization. In addition, Dr. Markus Walsh, GIS specialist at ICRAF, will be seeking training funds to support a student on the NDVI-Fecal NIRS pattern analysis proposed for the LEWS project.

Initial conversations with Dell Computers of Austin, Texas are currently underway, but it is too early to determine if they will commit to provision of the requested 40 computers to support the project. We have experienced difficulty in identifying key decision makers in the various motorcycle manufacturing companies, given the international thrust of the project and limited authorization of corporate managers within the Japanese-owned companies in the US.

Our goal is to link with the "Crisis Mitigation in Livestock System" project supported by USAID's Greater Horn of Africa program to broaden the impact of the monitoring and analytical components of the project. Our presentations at Naro Moru, Kenya will be our first efforts at cultivating this relationship.

The Grazinglands Technology Institute of the USDA-Natural Resource Conservation Service has agreed to fund a national project ($150,000) which will establish over 550 sites in 42 states for fecal profiling monitoring over the next two years. These funds will help develop greater analytical and technical capacity for sample processing and analysis by GAN Lab. They are highly supportive of the concepts proposed in the LEWS Global Livestock CRSP proposal and will submit a letter of support for the project stating that it will have direct benefit to their mission and impact a broad segment of the grazingland-based livestock industry in the US.

Future Activities

The level of organization developed to date allows us to have a clear vision of how the project will emerge and other opportunities that will emerge from expansion of the program in terms of geographic impact and human capital development within the region. Our approach to an integrated, spatial information system for the LEWS capitalizes on the prior investments in spatial data and GIS software associated with the Spatial Characterization Tool and the advances made in fecal NIRS profiling system. However, we will form teams within each country of the appropriate mix of professionals from NARs, IARs, NGO and PVO. The role of these teams will be to provide inputs into the SCT system to create the spatial delineation of the "effective environments" from the foundation and baseline datasets currently in SCT for East Africa. For Livestock CRSP objectives, we need to characterize the region into effective environments for the purposes of establishing our spatial sample frame for fecal sample collection. We have tools to facilitate this process ranging from the spatially interpolated climate surfaces to highly detailed PHYGROW output. Since we know the process of establishing a sample frame will be iterative and because the evaluation of any particular set of variables necessarily includes field checking and subsequent refinement, we will begin the process of effective environment determination through an assessment of the spatially interpolated climate surfaces. The national teams will then work to form sampling location teams within selected "effective environments." These teams will be comprised of NAR professionals, extension personnel and NGO staff. These "location" teams will then go through the process of selecting the appropriate sampling sites and pastoralists to work within an area and conduct the landscape and herd characterizations needed to support the modeling efforts.

We see the need for training packages for body condition and frame scoring livestock, proper handling of fecal samples, vegetation measurement and use of the information systems that will be fed back to the "location teams" via CD-ROM updates each month. There will be a need for several research projects to test the biology within the NUTBAL program such as verification of the Woodsman lactation curve and development of weight-age-frame-condition relationships for the East African breeds of cattle, sheep and goats. Evidence from ILRI's Debre Zeit research program indicates the milk yield is a curvilinear decline from parturition to weaning, not reflecting the peak at 45 days postpartum as assumed in the Woodsman equation. Given that NIRS will play a critical role in the monitoring system, there will be a need to conduct livestock performance validation trails across each country to identify weaknesses in the NIRS/ NUTBAL nutritional management system.

We will be faced with the establishment and training of personnel in eventually five countries over the life of the project. We plan to bring to the US personnel to work in the GAN Lab for training prior to setting up the labs in each country. GIS and modeling analysis capacity will have to be built over the life of the project as well. We will initially conduct the mass computational analysis within the facilities at TAMUS linked to ILRI's computing capacity via the internet. However, we will have to develop expertise and computer capacity within each country over time. GIS and APEX crop simulation training will be conducted by the IIML lab at the TAES Research Center at Temple, Texas. NUTBAL and PHYGROW training will be conducted on the TAMUS campus by the Ranching Systems Group and the Center for Natural Resource Information Technology.

This project offers a rallying point for organizations to interact within the region to address needs of people who depend on survival of livestock for their own survival. We see greater cooperation among NAR and NGOs emerging and tremendous opportunities to have a positive impact on both women and children within the region. If a pastoralist can make an informed decision as to movement or marketing of their animals, and a researcher can devise a cost-effective mitigation solution, while a policy maker has time to organize a course of action to reduce the effects of emerging problems, this Livestock CRSP proposal has built the framework for people to have a more stable life, while food security of women and children increases, and our ecosystems are offered a chance to recover. We do not pretend to have the "wonder technology." We understand that we are part of an infrastructure of organizations that impact the lives of people throughout East Africa. What we offer is technology that no other institution in the world is capable of currently providing and packaging in a manner that value-adds the efforts of existing information and monitoring infrastructures in East Africa. This project has tremendous potential to leverage with other organizations and institutions as the outputs of the monitoring and analysis system come on line in the region.

Objective Matrix

Objective 1 Impacts

IARCs, USAID, and other international development/aid organizations will be provided with a set of computer-based tools that are integrated for optimum use in regional scale monitoring systems for application on grazinglands worldwide, including the USA.

NAR and NGO in East Africa, specifically Ethiopia, Eritrea, Kenya, Tanzania, Uganda will be provided advanced regional planning tools that provide spatially explicit analysis of grazingland processes and a mechanism for direct linkages between pastoralists, national government and international development/aid organizations.

University students will have access to a global information source that can be analyzed for near real-time impact to allow a greater understanding of global forces and their impact on people and their livestock using grazinglands initially in East Africa, eventually worldwide.

Improved integrated information technologies will be advanced through the process of creating such a system and

Objective 1: To integrate the state of the art early warning tool into a cohesive methodology and demonstrate that the technology is appropriate and useable in East Africa

Outputs	**Impacts**	**End User**	**Action Required**	**Lead Team Member(s)**	**Time to Completion**
NUTBAL Integration with SCT	IARC, NARs, and USAID - increased analytical capability	USAID, IARC, NAR, NGO	Code to integrate NUTBAL with SCT	Corbett, Stuth	October 1998
GPS field monitoring protocol	IARC/NAR/NGO database integration	CRSP Team (NARs, NGOs, IARCs)	Workshop training & manual	Corbett, Dyke	
Web page, CD-ROM product	Global Information access via Internet/ CD-ROM	IARC, NAR, NGO, CRSPs, universities-Internet accessible	Web page program, CD-ROM production	Stuth, Corbett	
PHYGROW/APEX tuned to East Africa	Improved prediction capability for early warning	CRSP Team	Link APEX and PHYGROW to SCT	Stuth, Dyke, Williams, Harmon	
Refined spatial analysis method	Sample frame - more effective identification of representative sites	CRSP Team	Devise data management strategy and sample frame	Stuth, Corbett	
Georeferenced datasets for East Africa	Integrated livestock and grazingland conditions information	Governments, NGO, NAR, IARC, US universities	Creation of early warning SCT for Livestock CRSP Establish graduate research program on NDVI and NIRS fecal profile system at ICRAF, Nairobi	Corbett, Stuth, Dyke Stuth, Corbett	October 1999

Objective 1 continued.

Spatial sample frame for early warning	Improved allocation of resources in policy organizations	CRSP Team	Optimum sampling strategy (use of SCT)	Corbett, Stuth	
East Africa fecal NIRS calibration equation for cattle, sheep, and goats	Rapid service for technical advisors in East Africa	Governments, NGO,NAR,IARC, US Universities, FEWS	Field validation of NIRS fecal profiling system	Stuth	
	Improved research needs identification in ASARECA	NAR,USAID, FEWS	formalized	Stuth, Dyke, Corbett	
	Improved response to pastoralists and mitigation alternatives for GHA program	FAO, FEWS - Information and warning system IGADD	Establish East Africa NIRS lab at ILRI Addis Ababa	Stuth	
			Set up spatial early warning GIS operation at ILRI Nairobi	Corbett, Dyke, Stuth	

new research avenues will be identified to enhance the predictive capacity of a spatially based set of analytical tools for early warning systems.

A fecal NIRS profiling system will be established for East Africa which will provide a monitoring tool to determine the nutritional well-being of livestock in pastoral conditions in remote regions. The capacity to provide rapid service to technical advisors in East Africa will be built through the formation of NIRS fecal profiling laboratories in the region.

A rational approach to identifying livestock and range management research needs will emerge from the process of creating the early warning system in East Africa, thereby improving the effectiveness of problem identification by scientists in the Association of Agricultural Research in East and Central Africa (ASARECA).

The Greater Horn of Africa program will be provided a mechanism for improved response to the needs of pastoralists and improve the type of responses needed to mitigate and reduce the risk of drought.

Objective 1 Actions Required

A batch version of NUTBAL will be created that is capable of acquiring spatially referenced diet quality and herd characterization data via spatial databases in the Spatial Characterization Tool and predict crude protein and net energy balance in cattle, sheep and goats depicted across a landscape using advanced splining methodologies in SCT.

Develop methodologies for classifying virtual landscapes to allow modeling of forage supply and livestock demand for grazinglands (PHYGROW) and crop production (APEX) for output to gridded datasets within SCT.

Devise protocol for acquiring georeferenced data on weather, herd profiles, diet quality and forage conditions, crop conditions for use in SCT and interface with analytical models.

Final validation of the NIRS fecal profiling calibration equations for predicting dietary crude protein and digestible organic matter will be completed by Ph.D. graduate students at Addis Ababa, Ethiopia. Additional research requirements will be identified and pursued by appropriate cooperators to increase the robustness of the system, as needed.

The SCT tool will be used to establish an optimized sampling scheme for pastoral herds in East Africa considering climatic patterns, soils, elevation, human density and livestock population densities relative to road and organizational infrastructure of Ethiopia, Eritrea, Uganda, Kenya and Tanzania.

In-country coordinators will be convened to review the GIS-derived analysis and assess the areas chosen for monitoring activities. Prioritization will be allocated based on road accessibility and linkage to public transportation system (bus/car/motorcycle), availability of personnel (NAR, Extension, Other Governmental, NGO, PVO, International Aid/Relief), concentration of livestock concentration points/trailing routes, and telecommunications infrastructure. Optimization will be based on maximum land area/people impacted per grant dollar available for expenditure on monitoring activities.

Selected site monitoring routes will be established in each of the 5 countries which allow pilot testing of robustness of fecal NIRS profiling technology, herder interview techniques, weather recording, establishing a transport system for fecal samples to a central NIRS laboratory, perfection of a delivery system for collected weather, forage and herd information to central analysis laboratory, and data flow techniques between the NIRS laboratory and spatial analysis laboratory.

Graduate research program established to address a broad range of issues which enhance our ability to monitor and predict emerging crises in grazed ecosystems in East Africa and around the world.

A select group of site monitoring routes will be classified into virtual landscapes to allow testing of near-real time analysis by PHYGROW and APEX. This will allow us to work out techniques for characterizing virtual landscapes under East African conditions, devise weather data acquisition methodologies and assess the use of ENSO adjustments to weather projection probability distributions.

Objective 1 Team Members

John Corbett - SCT gridded dataset and model output manipulation.

Jerry Stuth - NUTBAL batch version and gridded input/output methodologies, PHYGROW virtual landscape methodology development.

Paul Dyke and Jimmy Williams - APEX virtual landscape and linkage with SCT developed.

Each team member will depend on interaction with SCT activities and his respective model interaction.

Jerry Stuth and Paschal Osuji verify that the NIRS system is stable for East African conditions.

Jerry Stuth, Ndelilio Urio, William Mnene, Cyprian Ebong and Paschal Osuji work on fecal profiling system and herd characterization methodology, including data delivery system.

Paul Dyke, Jerry Stuth, Jimmy Williams, Wyatte Harman work on virtual landscape and data integration issues for APEX and PHYGROW.

Paul Dyke and Jimmy Williams work on ENSO methodology for adjusting rainfall probability projections and distribution.

John Corbett, Jerry Stuth, Paul Dyke conduct SCT spatial analysis for proposed sampling zones.

All team members participate in selection of optimum routes for site collections of feces, herd information, forage conditions and weather.

All team members participate in field data collection methodologies and data delivery system.

Jerry Stuth trains and sets up in-country NIRS laboratory.

John Corbett trains staff and sets up GIS based analysis laboratory.

Objective 1
Developmental Relevance

The capacity to integrate on-ground monitoring technologies with spatially explicit analyses of grazingland landscape processes and human condition is a major limitation to comprehensive early warning systems targeted for grazinglands. A comprehensive set of analytical tools integrated with on-ground monitoring systems offer a mechanism to connect the pastoralists with the policy makers in a comprehensive system of feedback as temporal and spatial trends develop. Existing famine early warning systems (e.g., FEWS) would benefit greatly with the establishment of integrated information technologies and field monitoring systems.

A particular concern is that livestock owners are adversely affected by drought and political insecurity in East Africa. These catastrophic events have long term impacts on the people in affected areas through decreased food security, lost purchasing power and, in some cases, the livestock enterprise looses its ability to regenerate itself. During crisis, the curtailment of pastoralists' ability to move freely and market imperfections cause livestock prices to fall, often disastrously relative to cost of grains and feedstuffs. When pastoralists are seeking to restock their herds, livestock prices rise rapidly. Inappropriate policies promote the adoption of inappropriate short-term practices which lead to environmental degradation with long-term consequences. These factors make it increasingly difficult for pastoralists and other sectors in societies to recover between disasters and makes them more dependent on relief. A comprehensive early warning system would provide pastoralists with a greater perspective of pending risk, improve policy makers' ability to formulate more timely rational policies, and improve response time and targeting of affected areas by relief organizations. A more information-rich environment would help break the accelerating cycle of relief, shifting regions back into a development cycle. Reduced risk, allows pursuit of practices which improve efficiency of production which in turn lead to improved life status. The results can be improved human nutrition and greater stability of ecosystems for future generations.

Objective 2 Outputs

Pastoralists in an area of 100,000-180,000 km^2, in East Africa will be provided information which will lead to improved body condition of animals as compared to animals in non-monitored regions. Also, the information will lead to reduced nutrition-induced livestock mortality and earlier movement of livestock to more suitable areas resulting in higher end-of-dry-season standing crops for the monitored region.

Twenty-five percent of pastoralists in the monitoring zone will indicate that they have improved their understanding of the needs of their animals and the value of their grazinglands.

A series of 4 NIRS fecal profiling laboratories with be established in East Africa by the end of the 6 year funding cycle, resulting in increased analytical capacity for understanding livestock nutrition under pastoral conditions. The formation of the labs will increase the research capacity of ILRI and NARs in the region.

Objective 2 Impacts

In-country NAR, Extension and NGO organizations in East Africa will be able to form a monitoring infrastructure which will improve policy response time in a more efficient manner.

NGO/NAR cross linkages with ILRI will be strengthened leading to a more cohesive research policy for livestock production in East Africa.

Pastoralists will make more informed use of supplements thereby reducing costs and amounts of feed required for sustaining livestock in periods of seasonal drought.

Objective 2: To develop a network of collaborators to implement a full scale early warning livestock and food security program for East Africa.

Outputs	Impacts	End User	Actions Required	Lead Team Member(s)	Time to Completion
Pastoralists of East Africa will be provided herd condition information	Improved health and economics of livestock production in target region	In-country NARs, Extension, NGOs, and IARCs	Organize regional, zone, and site collection teams	Corbett, Stuth, Dyke	October 2000
	Improved monitoring infrastructure for pastoral regions in East Africa	USAID-FEWS	Establish iterative protocol for analysis of monitoring system	CRSP Team Corbett, Stuth, Dyke	
	More cohesive research program and policy for livestock production systems in East Africa	ASARECA	Implement regional-scale monitoring system linked to international policy organization		
	Improved short-term decision making by pastoralists	NGO, Extension	Design a pastoral information feedback system		
			Pre- and post- monitoring survey of pastoralists and partner institutions		
To USAID-FEWS and FAO Information and Early Warning System - more timely and accurate information	Improved policy and decision making for pastoral regions of East Africa	USAID- FEWS, FAO Information and Warning System, IGADD, ASARECA	This is the ultimate objective of our livestock CRSP	CRSP Team	
Construct additional NIRS fecal profiling laboratories	Improved region specific analysis	NARs, NGOs, Extension	Establish Laboratories in four countries	Stuth	2003

Famine early warning systems will be enhanced by increasing the quality of information on condition of pastoralists and their livestock. Ultimately, famine relief costs should be reduced for organizations providing food and feedstuff to stressed populations.

If fully implemented, an early warning system should diminish dramatic swings in livestock market prices, assuming no political disruption of populations, collapse of transportation systems or unexpected disease outbreak.

Objective 2 Actions Required

In country coordinators organize zone coordinators and site collection teams for collection of feces, weather data, herd information and forage conditions.

Regional scale monitoring system implemented and linked to international policy organizations, producing spatially referenced information on livestock trends in diet quality, nutrient balance, body condition, forage balance and emerging problem areas.

Iterative assessment protocol established for system performance and adjustment of procedures, delivery system and analytical capacity of the early warning system.

Development of feedback mechanisms to get information back down to pastoralist within the organization framework, newspapers and non-traditional informational outlets.

Pre- and post-monitoring survey of pastoralist located in and outside monitoring zones to assess pastoral decision certainty relative to information provided.

Pre- and post- project survey of organizational behavior of those institutions involved in the monitoring and analytical infrastructure of the early warning system. Periodic review of system behavior with subsequent organizational and procedural adjustments.

Objective 2 Team Members

Urio, Osuji, Sabiiti and Mnene organize a series of meetings to identify site collection personnel in each country with zone coordinators (Kidunda, Mwilawa, Ebong, Tegehne, Kumsa, Sileshi, Haile, Kiflewahid).

Stuth, Dyke, Corbett, Urio, Osuji, Sabiiti and Mnene conduct training workshop on collecting information and reporting information within the early warning network.

Stuth, Dyke, Corbett, Urio, Osuji, Sabiiti and Mnene review procedures and system behavior to make adjustments in performance.

Corbett and Dyke develop the CD-ROM information feedback system and Urio, Osuji, Sabiiti and Mnene work with their respective organization to get analysis of emerging conditions to their respective policy organizations and newspapers.

Dyke, Corbett and Stuth work with FEWS to get information flowing from the data analysis lab.

Objective 2
Developmental Relevance

A major limitation of early warning system is developing the proper institutional infrastructure and organizational linkages to foster communications of information to all levels of decision making and allow feedback to all levels in the system of livestock production on pastoral lands. Connectivity of policy, research, extension and the users of land is crucial to the effectiveness of information at all levels. Effective communication infrastructure leads to more rational, timely decision making at all levels in the system. In East Africa, there are a wide variety of resource and human related organizations, including governmental research and extension organizations, NGO, PVO and international relief organizations. Linkages of these organizations coupled with a comprehensive monitoring system under the umbrella of an early warning system would be a pivotal activity to increase the effectiveness of all organizations in terms of impact on pastoralists and the land they graze. Improved organizational responsiveness leads to increased policy lead time, reduced incidence of delayed decision making by pastoralists, and decreased negative impact on ecological and economic stability on grazinglands and the people that depend upon sustained productivity of livestock. The improved organizational structure would lead to improved research prioritization within the context of the newly formed Association Agricultural Research in East and Central Africa (ASARECA).

Publications

Executive Summary of Initial Planning Meeting - A handout for discussion with regional organizations explaining the purpose of the livestock early warning system in the Global Livestock CRSP, January 27-31, 1997.

Mid-Term Report - A comprehensive report on progress of the Global Livestock CRSP - Livestock Early Warning System-October 1 to March 1, 1997.

Report on the Assessment Team Planning Meeting in Addis Ababa, March 17-21, 1997.

Report on fecal profiling analysis for distribution to AT, July 1997.

Abstracts, Presentations and Workshops

Stuth, J.W., J. Corbett, J. and P. Dyke. 1997. Integration of NIRS fecal profiling technology with the Spatial Characterization Tool and simulation modeling to create an information infrastructure to support an livestock early warning system in East Africa. Proc. Crisis Mitigation of Livestock Systems in the Greater Horn of Africa Program. ASARECA. Naro Morul, Kenya. July 6-10, 1997.

Initial Assessment Team Workshop. ILRI Campus, Nairobi, Kenya, January 27-31,1997. Formation of in-country coordinators and training on use of GPS and fecal profiling system.

Final Assessment Team Planning Workshop, ILRI Campus, Addis Ababa, Ethiopia. March 17-21, 1997. Assembly of entire assessment team from five countries to review the NIRS/NUTBAL system, SCT spatial analysis tool, PHYGROW and APEX simulation modeling environments and general project protocol and design.

Wrap-up Workshop with Key Assessment Team Members. Naro Moru, Kenya - Crisis Mitigation in Livestock Systems- Greater Horn of Africa Program. Review of data collected over 9-month assessment period and final review of early warning system proposal.

Collaborating Institutions

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Negotiating Transitions: Small Ruminant Technologies for Zones Under Pressure in East Africa

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Foreword

Please note that this report only covers one activity of the many undertaken this year in all four SR-CRSP projects in Kenya, Regionalization of the Kenya SR-CRSP components to East Africa. Other activities by animal health, breeding, production systems and social sciences projects are reported elsewhere in this publication. Estimated budget contributed by all the projects to this activity was $20,000. Many people have contributed to this proposal, more than the team matrix reflects. We are thankful to all the people we worked with in Tanzania, Uganda and Kenya, to ILRI and ICRAF for their patient input, and the people and organizations represented at the regional participatory planning by objectives workshop of March 20-21 1997. We are indebted to KARI and Dr. Ndiritu for hosting this meeting.

Narrative Summary

Negotiating transitions: Small ruminant technologies for zones under pressure in East Africa, is the result of a participatory process to assess the strengths of the Kenya SR-CRSP with potential collaborators from the East Africa Region. Through the past nine months the team traveled to Tanzania and Uganda to present and discuss regionalization in new research areas that build on the needs of each country and the strengths and expertise developed by the Kenya SR-CRSP. Several workshops were conducted, two country specific, one regional, and several follow-up meetings to assess sites, collaborators and ongoing goat development projects. A partnership was built among research institutions, both national and international non-governmental organizations working in the region, local grass roots organizations and universities to identify the objectives and activities for a three to six year program in the region.

The research proposal for regionalization aims to contribute to food security and economic growth in rural areas of resource poor farmers in mixed crop livestock systems. It addresses: a) individuals and households that benefit from diversification through small ruminants, with a focus on the impact on women, as past assessments show small ruminants as women's domain; b) sustainable multiplication strategies, such as the ongoing multiplication of the KDPG with large commercial, small farmer group multiplication ventures, to develop methods that are useful in any introduction of small ruminants in the region; c) integrated approaches to Haemonchus control; and d) enabling environments for demand driven research, to effectively interface with development. Assessment methods will be developed to measure impact and adoption of technologies on households, groups and enterprises, and to evaluate social capital in technological formulation, dissemination of information and adoption. Demand driven sustainable multiplication models, will be designed for the KDPG and other breeds. Human capital development through research training on-farm, and development of participatory working groups integrated by farmers, non-governmental and extension personnel, and researchers are integral to the proposal. Long run effective demand driven research depends on well-trained researchers that will develop technological alternatives based on farmers needs.

This project has developed partnerships in the US with Heifer Project International, Virginia State University, Washington State University, Winrock International, and University of Missouri as the leading institution. In the region, partnerships have been developed with the Kenya Agricultural Research Institute, HPI, International Livestock Research Institute and the commercial multipliers of the KDPG in Kenya. In Tanzania a partnership was developed with Selian Agricultural Research Institute, the Livestock Production Research Institute, World Vision, The Evangelical Lutheran Church, Sokoine University of Agriculture, and HPI. In Uganda our collaborators will be the National Agricultural Research Organization, Makerere University, the Busoga Diocese, HPI, and Joy Children Center. Our aim is to contribute to the development of livestock technologies and methods that facilitate the transition of farmers and households from a mainly subsistence and food insecure reality, to one in which individuals and their households achieve food security, economic growth, and empowerment.

Problem Model

In line with the Global Livestock CRSP, *Negotiating Transitions: Small ruminant technologies for zones under pressure* responds to a call for continuation proposals by the SR/GL-CRSP Management Entity of the University of California in July 1996 (UCD, 1996), and to recommendations by the External Evaluation Panel Report of 1996, and the Advisory Panel Meeting of October 1995 (UCD, 1995). It reflects the goals and objectives of the reengineered CRSP, addressing priority areas identified by the East African Regional Livestock Assessment Workshop (UCD, 1996). The assessment team proposal fits with the refocused Livestock CRSP, because it targets priority number one of the Economic Growth/Policy thrust: "Ensuring the food security and development needs of resource poor households, with the objective of using livestock, especially small ruminants to enable resource poor households to cope with stress and enter the monetary economy" (UCD, 1996).

The problem model addressed is food security and economic growth for resource poor households in rural areas of East Africa. It focuses on achieving security and growth by providing alternatives that diversify the economic portfolio through livestock technologies. We address this problem as we believe that regionalization of the Kenya SR-CRSP to East Africa must be grounded on experiences of the current SR-CRSP to identify new directions. We started this process by proposing directions that could be delivered in the given time frame, assisting farmers in the transition from mostly subsistence to increasingly market-oriented activities, and focusing on negotiations that farmers and farmer's groups, researchers and developing agents, engage in to foster economic security, growth, and empowerment necessary for fostering democracy.

The problem model encompasses several actors and layers in the continuum of research and development, including the household and the individual. The individual consists mostly of women as they engage in livestock and household reproductive activities (Boserup, 1990; de Haan et al, 1996; Njeru, 1997; Valdivia and Nolan, 1996). We focus on the contributions of the livestock enterprise as a vehicle for economic growth of the household; the empowerment of women, as a safety net as they control the enterprise and access to high quality proteins (milk and meat); the environment through proper management of livestock and nutrient cycling; and the social mechanism that ensure the viability of the enterprise.

It also addresses identified needs in the region for multiplication strategies and models applicable to diverse types of breeds. Several development organizations use goats as a means to increase the welfare of very resource poor households, and to further diversification. We chose the Kenyan Dual Purpose Goat multiplication strategies as a case study for sustainable demand driven models. Large commercial multiplication of the KDPG, a strategy pursued, is already ongoing at two commercial farms in Kenya. Our intention is to build demand driven commercially viable strategies, with farmer groups, large commercial multipliers and private voluntary organizations. The farmer and the group levels will be studied to determine social conditions and networks that build on social capital, and contribute to development and adaptation of technologies and new enterprises. Goats as an evaluation of enterprise within a household unit, contribute to the methodologies for evaluating microenterprises.

The research on station will concentrate on Haemonchus Resistance, through an integrated approach that includes genetic resistance, animal health through pen-side tests to provide cost effective recommendations on Haemonchus treatments, and work with farmers to identify best and second best options to deal with the constraint. All these are in line with increasing efficiency.

A fourth layer is human capital development in National Agricultural Research Systems, universities in the region and the US, and non-governmental organizations and networks currently working in development through small ruminants and other livestock alternatives. Our approach is to negotiate this process by developing on-farm research capacity, at the enterprise and multiplication levels. We capitalize on human capital developed by the SR-CRSP in the region as a viable alternative for development that must be designed from within (Delgado, 1996).

In all these layers several actors are identified: the farmers and their groups, the NGOs and extension agents, the researchers, and the donors. Each of these actors play roles that are changing as we move towards a multiple knowledge paradigm. Negotiations among these actors at different layers becomes central. Methods to assist the process by which research needs are identified at different layers with all actors involved will facilitate the interface of research and development.

Original Hypothesis

Introduction and regionalization of the already developed and tested Kenya Dual Purpose Goat technologies into the high potential and semi-arid areas of East Africa will lead to improvements in household and community incomes. This will provide economic and food security, fulfilling safety first requirements to allow diversification to other economic activities.

General objectives and activities were identified at the March Conference (Travel Report, Valdivia, March, 1997). These were further refined at the May Workshop in Columbia, Missouri. In a refined hypothesis no distinction was made of the agroecological zone, though there was agreement that the focus should be highland and semi-arid mixed crop livestock systems, as these were identified as areas of high pay-off in growth and sustainability impacts (WI, 1992; Gardiner and Devendra, 1995; UCD, 1996).

The general objectives defined at the Participatory Planning Workshop (Nairobi, March 1997) were redefined in order to contribute to diversify farmers options in a sustainable manner:

- Incorporate an enterprise that diversifies the economic portfolio of household members and individuals in rural areas.
- Develop livestock multiplication strategies off-station that are sustainable, and therefore provide animals for the market.
- Develop demand driven research agenda to guarantee adoption and impact, through off-station research activities, and providing and integrating networks of all actors.
- Continue to develop a cadre of researchers in Africa and globally that can effectively work in a demand driven environment.

Developmental Relevance

Food Security and Economic Growth

Rural areas of East Africa suffer from food insecurity resulting in high levels of malnutrition affecting 30 percent of the population (Sharma et al., 1996). The highlands and semi-arid areas are a special challenge as these concentrate the highest level of malnutrition, between 20 and 40 percent (Sharma et al., 1996). These areas are confronted with the challenge of securing their livelihood while increasing the productivity of their resources to cater to the increased market demand to increase production through productivity rather than expansion of the agricultural frontier, a path taken in the past (Eponou, 1996). Added to this challenge is to achieve this through sustainable means that protect and increase the quality of its resource base.

The green revolution left out semi-arid environments and the highlands, resulting in a lack of supply of appropriate technologies. Semi-arid zones, the warm sub-humid tropic zone, and the cool tropic zone experienced the smallest increase in land and labor productivity (Sharma et al., 1996). Probable causes of less productivity in the highlands are inferior resource base, harsher climate, and topography. Therefore ... "increasing food production in rain fed areas in ways that conserve and enhance their resource base is an extraordinarily difficult task, given the uncertainty of rainfall" (Sharma et al., 1996,11). Semi-arid areas are especially characterized by low productivity and droughts (Gill, 1991), which periodically cause famine, as households are unable to cope with these perturbations. As a consequence, human nutritional stress is prevalent and generally inadequate. High population density, land fragmentation and intensive cropping characterize highland areas.

Fat intake is very low in children and their mothers, as a study in Kenya showed (Calloway, 1995). "It is the micronutrients supplied predominantly by animal products or affected by their presence that are likely to be deficient in the diets of Kenya toddlers" (Calloway, 1995, 15). Milk and cheese intake marked better growth in children. This underlines the importance of seeking interventions that will increase the level of animal outputs, income and economic security at the household level, in highland and semi-arid regions, and that technologies should be in the domain of individuals that have an impact on household nutrition.

Liquid assets, such as the KDPG, off-farm migration, and diversifying the economic portfolio, are strategies that contribute to smoothing consumption and increasing food security. (Gill, 1991, 54). Development of a sustainable enterprise and demand driven commercial multiplication strategies contributes to alleviating these constraints, as will be presented next. In the process of development of viable goat small ruminant enterprises diseases and animal health services have been identified as an important constraint (WI, 1992; Gardiner and Devendra, 1995).

Contribution of Small Ruminants: The Kenya Dual Purpose Goat

At the household level, smallholder resource poor farmers in crop-livestock systems of East Africa are faced with consumption and income shocks resulting from variable climate, volatile prices, diseases, pests and other idiosyncratic risks. In this context small ruminants have been found to act as a buffer and a mechanism to smooth consumption and income. Small ruminants generate outputs such as milk and manure, while playing an important role as liquid assets. Households may liquidate them in times of stress (Meltzner, 1995; Fafchamps et al, 1996; Reardon et al, 1989; Nyaribo et al., 1995).

Small ruminants are usually the domain

of women in mixed crop livestock systems (Valdivia and Nolan, 1996; Njeru, 1997; de Haan et al., 1996; Sheikh and Valdivia, 1993), with a primary role in resource and output allocation, especially milk, and marketing, often depending on the culture (Lutta, 1997). Research shows (Kusterer, 1989) that the process of accumulation starts by securing a certain level of safety and not risking current living standards. Only when an insurance mechanism, the goats and the groups in this case, are satisfied, will the households invest in higher yielding and higher risk income generating activities.

Safety First, Diversification, and Investment. Risk management ex ante calls for diversification, integrating a new economic enterprise diversifying the economic portfolio, and accumulation. Ongoing processes of change increase the uncertainty and risk in which decisions are made by households, who follow a "safety first" rationale (Kusterer, 1989; Dunn, Kalaitzandonakes and Valdivia, 1996). This implies that households will not make decisions that will endanger their current level of security and their ability to reproduce their household economy.

Groups and Network: Social Capital and Farmer Groups: In organizing multiplication, investment possibilities, diffusion of information, formulation of goals, constraints, identifying needs, accessing inputs (animal health), and credit (group lending forms).

Research on impact assessment of the KDPGs on farm indicates that the KDPG is an activity that integrates and diversifies the economic portfolio, dominated usually by the female head of household, as off-farm employment and seasonal migration accentuated during drought periods, is common in Machakos (Gill, 1991). At the Coast income generated by the KDPG enterprise after two years is equivalent to remittances, and is important in areas where access to credit is low or non-existent. Liquid assets, such as small ruminants are important in a diversification strategy that contributes to reduce market and climatic risks, as well as maximizes use of available resources (Valdivia and Nolan, 1996)

For a large number of households in these areas in transition, goats are a major source of food and income. The traditional goat production systems rely on indigenous breeds whose overall productivity is generally low and whose disposal to market is determined by immediate monetary needs rather than any other biological criteria. Given the population increase in these areas, and growth in demand for food of animal origin, there is need for appropriate and widely applicable technologies that can increase goat productivity in these areas, and overall food availability.

The KDPG is a tropicalized composite breed of goat composed of equal proportions of Toggenburg, Anglo-nubian, East African and Galla that has the potential to survive and thrive in the marginal areas with proven off-take in small scale holdings. The Kenya Dual Purpose Goat is a viable intervention for such marginal areas introduced as a breed in small scale pure breeding schemes or upgrading schemes using KDPG bucks to genetically improve the productivity of other local breeds. This is one way of incorporating high performance genes without the negative genotype by environment interactions.

Although the markets are not very well developed in these areas, the KDPG has a high potential for growth rate (about 75 g/day in pre-weaning growth) and milk production (peak yield 2.0 Kg of milk per day with supplementation). Therefore, the turnover of realized products in the young markets will not only raise incomes and nutrient intake per household, but also stimulate community development ensuring sustainability of the introduced technology. This may contribute to increased availability of milk and marketable surplus, providing income for the development of new microenterprises, and increase smallholder commercialization.

The potential for socio-economic impact with the KDPG at household and community level such as women self-help groups, schools and rural training centers is high compared with high potential and peri-urban areas where there are a multiplicity of alternative sources of household and community income. Our focus on smallholders and goats lends itself to work with women because of the high rate of male out migration that leave women as the primary farm and household managers.

The Contributions of the Research Proposed by This Team

The aim of food security and economic growth in East Africa, and the rest of the world will be accomplished through integrated approaches that bring together all actors involved in the process of change and provide alternatives that are flexible and can be inserted in the economic portfolio of resource poor households. As many have stated (Eponou, 1996; Scherr and Hazell, 1993; Delgado, 1997), it requires a different perspective, one that includes all actors, from the individual and groups that incorporate and transform these options to the developers of the ideas and alternatives and those that present and transform them as options. Traditionally called the researchers, producers and extension and development agents, this proposal offers an opportunity, through small ruminant technologies and alternative enterprises, to bring together these institutions, to formulate, evaluate and transform options that are viable for the development of small ruminant enterprises.

From the principle of partnering with farmers groups, commercial farmers and non-governmental organizations, to the actual development of strategies for multiplication and conducting research in small and large commercial farm settings, this research aims to develop methods.

Constraints addressed by this problem model are those identified by several assessment studies. These include food insecurity and lack of economic growth, lack of empowerment of individuals, especially women, sustainability of crop-livestock systems and nutrient cycling, Helminthiasis, genetic resistance, lack of social science research experience, and the need to build partnerships to foster market integration and economic growth.

Assessment Team Process and Progress

Following is a time line of activities pursued in the development of the proposal:

- October 96: Missouri and Nairobi Workshops
- Nov-Dec 96: Concept Paper Development
- January 97: Tanzania and Uganda Workshops
- February 97: Tanzania and Uganda Position Papers and visit with potential collaborators
- March 97: Regional Participatory Planning by Objectives Workshop
- April 97: Tanzania and Uganda site visits and participatory appraisals
- May-July 97: Final Proposal Formulation and Review

Overview of Activities and Progress

The annual workplans of the four projects that form the two Kenya CRSP components, stated that the principal investigators would assess if there were products and experiences from the Kenya SR-CRSP that could be regionalized to East Africa. At a meeting in October, they and collaborators in Kenya agreed to prepare a proposal that would focus on the regionalization of the Kenya Dual Purpose Goat Approach and Technologies to East Africa, focusing on activities that would increase food security, market integration and commercialization in communities in transition. Agroecological conditions (semi-arid and highlands) and budget constraints were factors in the selection of Tanzania and Uganda to build partnerships for regionalization.

A concept paper was developed and presented at workshops in Tanzania and Uganda, attended by their national research organizations, non-governmental organizations, both local and international grass roots organizations, and with university faculty. With our potential collaborators, visits to farmers, sites and facilities took place at three opportunities, both in Tanzania and Uganda. This was possible with the support of KARI and potential collaborators.

As intended, a Participatory Planning by objectives took place in March. Along with the researchers NGOs and farmer groups from Kenya, Tanzania and Uganda, international centers (ILRI and ICRAF) participated. At this workshop the objectives and general activities were identified, as well as the sites and main contact people of each country team. The teams are not only interdisciplinary, they represent several stakeholders, research, extension, non-governmental organizations, and farmers groups. The Tanzania and Uganda position papers were presented at the workshop as part of the planning. Ample interest in the proposed activities was also notable in the case of NGOs working with resource poor families that use goat projects as a means to improve household welfare. We are partnering with Heifer Project International, with the Joy Children Center in Uganda, with FARM Africa in the development of networks and assessment of goat multiplication strategies.

As part of the regionalization, potential sites for multiplication were evaluated. Another workshop was held in Missouri in May, to narrow the objectives and activities identified at the workshop, that were ample and general, as reported in Valdivia's March 1997 trip report. Commercial multipliers in Kenya continue to grow as part of the regionalization activities (see Taylor report).

The team evolved and new partners in the US were incorporated as activities were identified. Virginia State University reflects a shift to multiplication, and integrated Hameonchus control, collaborating in Haemonchus resistance research with KARI and Washington State University. A partnership with Heifer Project International to collaborate on new approaches to integrate research and development. The increase interest in nutrient cycling (WI, 1992) and soil fertility constraints resulted in a partnership with Dr. Moses Onim of Winrock International (WI). Dr. Bob McGraw, Agronomy at MU, will assist on resource evaluation and training opportunities. In the development of social science research in the region (WI, 1992), Dr. Henk Knipscheer of the Social Sciences Research Network (WI) was enlisted to develop small grants in social sciences. A partnership with the Market-oriented Smallholder Dairy team at ILRI lead by Dr. W. Thorpe, through Dr. S. Staal has also been identified.

Dr. Jerry Taylor from Texas A&M was unable to continue in this new phase, but along with Dr. Francis Ruvuna contributed to this proposal. Dr. Jim Yazman worked closely with us, but with the shift from farming systems research to nutrient cycling and soil fertility Dr. Onim was identified.

Linkages with all the potential collaborators have been established, potential sites for multiplication and assessment of the KDPG identified. An integrated animal health research plan for the enterprise, multiplication models and Haemonchus research, are being developed. Research on group approaches to technology integration, and the role of social capital on impact of development projects and technological adoption is ongoing. A web site for information dissemination, and a private list for the proposal development and discussions were developed this year. Several NGOs were identified and contacts established.

Work with students to develop their Ph.D. research proposals in line with activities identified continues. A Kenyan student completed a two semester internship on women groups and the KDPG impact assessment. Finally, through the activities in breeding, a third commercial multiplier has been identified and a contract was signed. There are now three commercial multipliers of the KDPG in Kenya.

Future Activities

The two general objectives, and several activities were identified at the March Participatory Planning Workshop. These were discussed, refined and narrowed to four more specific objectives and corresponding outputs and activities. These are:

Objective 1: *Multiplication systems that provide farmers access to improved small ruminants in East Africa*

Outputs/Products:

A. Sustainable demand driven multiplication of the KDPGs in Tanzania Uganda and Kenya which includes commercial and farmer group multiplication strategies.

Activities/Actions Required:

1. An interdisciplinary baseline assessment of existing multiplication and extension strategies, potential multipliers, and markets distribution strategies for KDPGs.
2. Evaluation of genetic resources to design multiplication and distribution schemes.
3. Design appropriate monitoring techniques for performance evaluation, and economic analysis.
4. Establish nucleus breeding units or open nucleus as appropriate.
5. Establish registration of KDPG breeding association in Tanzania and Uganda.

B. Process for sustainable demand driven off station multiplication for goats.

Activities/Actions Required:

1. Develop an instrument for the socioeconomic and technical assessment of the viability of multiplication strategies.

Objective 2: *Develop and evaluate sustainable goat enterprises for resource poor farmers.*

Outputs/Products:

A. Develop a sustainable goat enterprise that diversifies the household economic portfolio

Activities/Actions Required:

1. Provide cost effective animal health options for farmers.
2. Feed resource utilization strategies, and nutrient cycling.
3. Household models to: a) evaluate adoption and impact of the KDPG on the economic portfolio and diversification; b) measure impact on women and household welfare; and c) measure the effect of markets on adoption of technologies to provide policy recommendations.

B. Establish three working groups to assess goat enterprise research which include farmers, NGOs, and researchers interacting horizontally in the region.

Activities/Actions Required:

1. Develop concentration groups that include farmers, researchers, non-governmental organizations, extension, private sector and government agencies, that meet twice a year in each country to assess activities, evaluate progress and review proposed activities for the following year.

Objective 3: *Develop integrated strategies for Haemonchus control.*

Outputs/Products:

A. Identify twenty new resistant goats in the nucleus herd.

Activities/Actions Required:

1. Performance-tested elite Haemonchus resistant breeding group that maintains meat and milk production traits.

B. Penside test for haemonchosis.

Activities/Actions:
1. Develop a pen-side cELISA to estimate Haemonchus burden in goats and sheep.

C. Critical evaluation of local treatments for internal parasites.

Activities/Actions Required:
1. Identify one promising local treatment for internal parasites.

Objective 4: *To contribute an enabling environment, focused on human capacity, that improves demand driven research*

Outputs/Products:

A. Internships and graduate research opportunities that contribute to development of on-farm research capacity in a three year frame work.

Activities/Actions Required:
1. Identify activities in Objectives 1, 2, and 3 that incorporate interns from Sokoine Agricultural University, or M.Sc. and Ph.D. students from Makerere University or University of Nairobi.
2. Prepare proposals to Rockefeller Doctoral Research Grants in Agricultural Economics.

B. Methods to identify and strengthen group based approaches that facilitate formulation development and integration of goat technologies.

Activities/Actions Required:
1. Baseline assessment of non-governmental organizations, and grass roots organizations working with farmer groups in goat development projects.
2. Develop two case studies of distinct approaches to development with goat enterprises.
3. Develop indicators to assess groups for success in developing enterprises and information flows.

C. Participation in existing networks and lead a yearly regional meeting on the interface between research and development of livestock technologies in East Africa.

Activities/Actions Required:
1. Yearly Small Ruminant Workshop in conjunction with group meetings, and in collaboration with NGOs, research institutions and universities, in a rotating basis in Tanzania, Uganda and Kenya.
2. Local contests to promote goats and goat production, that would include promotion of goat milk and meat, use of by-products and judging of animals or farmers competitions where participants visited farmers and assessed progress during a field visit.
3. Establish a Web site with discussion areas, publications and information ongoing research and development activities. Arrange access to these electronic networks.
4. Participation in the Regional Livestock Network (ILRI), TAGONET (Tanzanian goat network), and others to promote integration of stakeholders.

Objective 1: Multiplication systems that provide farmers access to improved small ruminants in East Africa.

Outputs	Impacts	End Users	Actions Required	Team Members	Time to Completion
1. Sustainable demand driven multiplication of the KDPG in Tanzania Uganda and Kenya	Four multiplication centers that will provide a reliable supply of KDPGs 350 families receiving KDPGs in the region	Producer groups Farmers Non governmental organizations Commercial multipliers	1.1 Baseline assessment of existing multiplication and extension strategies, potential multipliers, markets and distribution strategies for KDPGs. Gender analysis will be conducted.	Soc. Sc., An. Sc., Agron, An. Health, NGO	Kenya Tanzania Uganda year 1-2
			1.2 Evaluate genetic resources to design multiplication and distribution strategies.	An.Sc., An. Health	Tanzania year 1 Uganda year 1.5
			1.3 Design monitoring techniques to evaluate performance, economic and social impacts, gender and group analysis.	Soc. Sc., An. Sc., NGO	Tanzania Kenya Uganda year 1
			1.4 Establish nucleus breeding units or open nucleus as appropriate.	An.Sc., Soc. Sc., NGO, An. Health	Tanzania year 1 Uganda year 2
			1.5 Establish registration of KDPG breeding association.	NGOs, An. Sc., Soc. Sc.	Tanzania year 1 Uganda year 2
2. Process for sustainable demand driven off station multiplication for goats.	To sustain productivity of improved and exotic goat breeds in East Africa	Non Governmental Organizations Farmers groups	2.1 Develop an instrument to assess technical and socioeconomic viability of farmer group multiplication.	Soc. Sc., An. Sc., Agr, An. Health, NGO	For all countries in year 1 - 3
			2.2 Assessment of goat multiplication projects, including women and farmers groups, and the KDPG experience to recommend profitable goat (small ruminant) multiplication strategies.	Soc. Sc., An. Sc., NGO	Tanzania Kenya 1-3 Uganda year 2-3
			2.3 Training manuals for community based multiplication strategies, feed, health, management, and socioeconomic evaluation methods.	Soc. Sc., An. Sc., Agr, An.Health, NGO	Tanzania Uganda Kenya year 3
			2.4 Develop a GOAT Web site for diffusion of research and development of multiplication strategies in Africa.	Soc. Sc. and groups	East Africa 1-3

Developmental Relevance: Non governmental organizations and grass root organizations develop goat projects as a vehicle for increasing resource poor farmers welfare. Actions in this objective contribute to strategies that provide the market with goat breeds that improve milk and meat availability. In a new environment the commercial multiplication efforts are in line with the development of an increased market economy.

Objective 2: Develop and evaluate sustainable goat enterprises for resource poor farmers.

Outputs	Impacts	End User	Actions Required	Team Members	Time to Completion
1. A sustainable goat enterprise that diversifies the household economic portfolio and empowers the individual.	10 to 20% increase in income Increase in liquid assets by 20% Increase in milk intake by household members Decrease in consumption shocks	Resource poor households, Women in rural households	1.1 Provide cost effective animal health options for farmers.	An. Hlth., Soc. Sc.	Year 1.5 in Tanzania and Kenya, year 2 in Uganda
			1.2 Assessment of feed resource availability and utilization / soil fertility and nutrient cycling.	Agr., Animal Sc.	From year 1 - 3 at sites where the enterprise is evaluated
			1.3 Evaluation of impact of existing KDPG enterprise, and goat enterprises on the economic empowerment of women, and effects on household food security.	Soc. Sc., An. Sc., An. Hlth., NGOs	Yearly 1-3 at all sites
			1.4 Evaluation of the adoption of the KDPG in a household economic portfolio framework, production system context, and of the enabling environment on adoption.	Soc. Sc. with collaboration of team	At the end of each year all sites

Objective 2 continued.

2. Establish three working groups for the goat enterprise which include farmers, NGOs, and researchers, interacting in the region.	Diffusion of information in a context of high transaction costs Three working groups in East Africa	Farmers, NGOs, Research Institutions, Policy formulation entities	2.1 Organize a yearly meeting of collaborating members with producers, development and research actors for participatory evaluation of on-going and future activities.	HPI with MU and team	Year 1 Tanzania and Kenya, Year 2 Uganda, Y 3 Kenya
			2.2 Develop a directory of institutions involved in goat research and development, including action groups in rural areas, women empowerment programs, microentreprise services, and research projects in the East Africa Region.	In country coordinators with Soc. Sc.	Through out the years, available by the end of year 2.
			2.3 Assessment of on-going goat development programs with NGOS and grass root organizations with enterprise, individual and household levels of analysis.	An. Sc., Soc. Sc., NGOs	From year 1-3 at all sites for comparison.

Developmental Relevance: Resource poor farmers in the mixed crop livestock systems suffer malnutrition and economic insecurity. Goats diversify the economic portfolio, reduce risk, and are liquid asset for investment. 20 and 40 percent of the population in semi-arid and highland suffer malnutrition. Increasing agricultural growth by 2-5% in 15 African countries would save $900 million in food aid by 2005. (*Monday Developments*, p 4, May 5, 1997.) Activities address priority constraints. (WI, 1992). This region has 46.2% of the goat population in S.S. Africa (WI, 1992). 145 million people lived in semi-arid and highland rural zones, 118 million mixed (McIntire et al., 1992).

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Nicoline de Haan. Doctoral Candidate Rural Sociology, Awarded a Brown Fellowship $3,500 to study social capital and groups in technology development.

Dekha Sheikh, the Summer Institute for African Agricultural Research (SIAAR) fellowship for 1997. University of Wisconsin at Madison. Research proposal: "Towards More Sustainable Regional Agriculture: Households, Decisions, and New Technologies in Crop-Livestock Systems".

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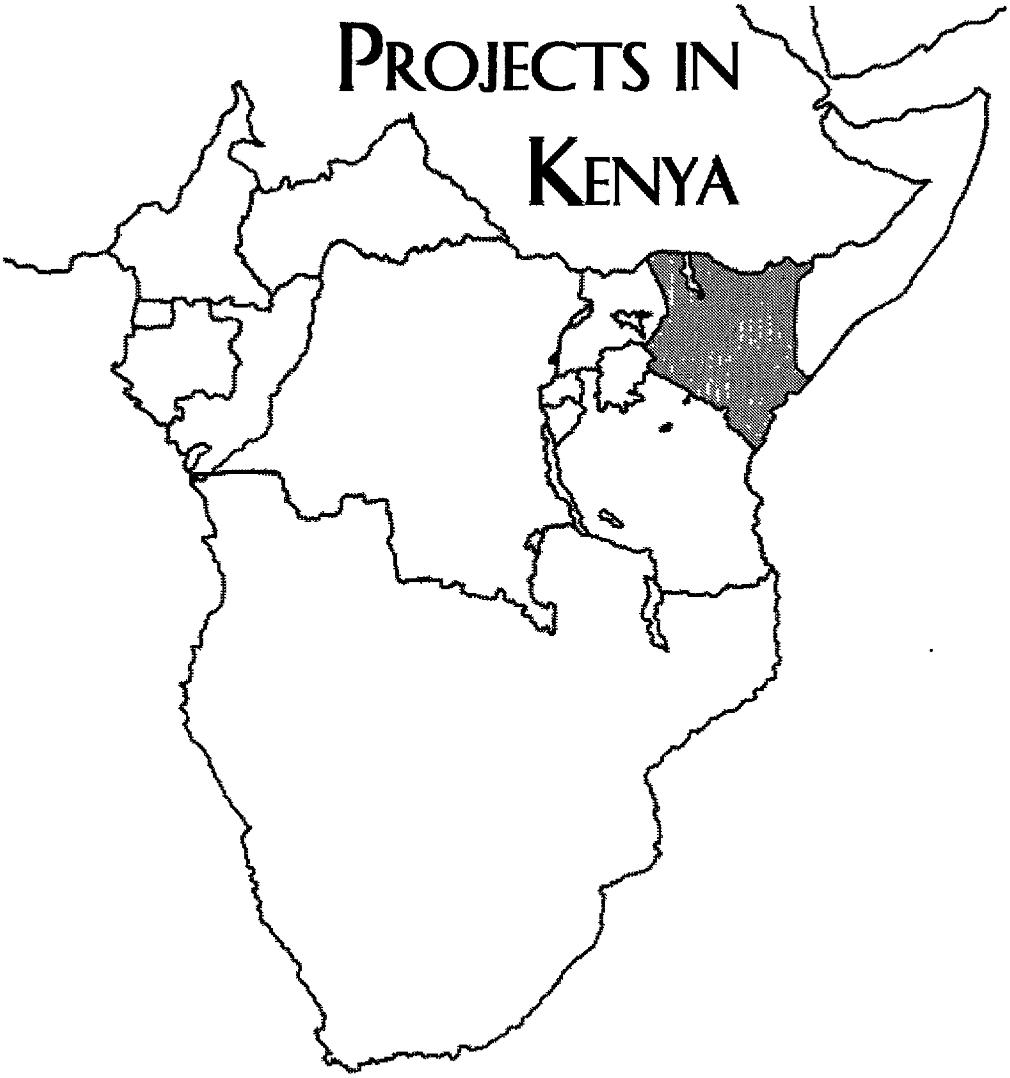
PROJECTS IN KENYA



MULTI-VALENT VIRUS-VECTORED VACCINE FOR GOATS AND SHEEP

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NARRATIVE SUMMARY

The problem being addressed by this component is that infectious diseases including internal and external parasites continue to constrain efficient sheep and goat raising and to limit the introduction of improved breeds. To make vaccines that control important diseases more readily available and economical to distribute and use, we are developing multivalent virus-vectored vaccines which could induce protection against several infectious diseases. These vaccines have several advantages over univalent vaccines including economy of production and distribution as well as not requiring expensive refrigeration lacking in many countries. The same virus vector can be used for sheep and goat vaccines and many of the vaccine genes can be used for diseases occurring in both goats and sheep.

Successful tests of our recombinant capripoxvirus (CPV) vaccine expressing genes from the Rift Valley fever virus (RVFV) were performed under containment conditions in both mice and sheep. Groups of sheep immunized with rCPV-RVFV vaccine were protected against a challenge with either RVFV or capripoxvirus. This indicates that the vaccine induces immunity to two different infectious diseases of sheep and goats. This CPV vector could be used to deliver a multivalent vaccine in the host country (Kenya), the rest of Africa, all of Asia, and possibly several other areas of the world. Studies on the duration of immunity to rCPV-RVFV are needed and genes from other organisms need to be added to increase the valance of vaccine. Even though native proteins encoded by the GA1 gene from *Haemonchus contortus* induce a protective immune response in goats, an initial experiment using a DNA vaccine expressing GA1 was unsuccessful. Another goal was to clone the M segment from Nairobi sheep disease virus (NSDV) for inclusion in the recombinant CPV vaccine. A cDNA library was made which contains inserts from NSDV and these are ready for screening to determine if any express the M segment proteins. The component also participated in the assessment of the health management of the Kenya Dual Purpose Goat (KDPG) in various sites in Kenya and in the preliminary field evaluation of the CCPP vaccine. Strategies were identified to control diseases in the KDPG study sites that are effective and affordable by the farmers.

RESEARCH

Activity: Evaluate protective immunity induced by a new recombinant CPV expressing Rift valley fever virus glycoprotein genes (rCPV-RVFV).

Problem statement and approach

The problem was to develop a safe virus vector that would also express foreign genes in such a way to induce protective immune responses to the proteins encoded by the foreign genes. CPV, the cause of goat and sheep pox, was selected because these are important diseases in countries throughout Africa and Asia; and because CPV is attenuated and is already being used as a vaccine in sheep and goats. In addition, some gene insertion sites and insertion plasmids have been described which work with CPV.

Progress

Experiments were completed in mice which involved inoculating groups of 10 mice either intraperitoneally or intramucularly with rCPV-RVFV. Then, these 20 mice plus 10 control mice were challenged with approximately one hundred 50% lethal doses of RVFV. All the control mice died within 7 days of challenge, while none of the mice inoculated intraperitoneally died and only one of 10 mice inoculated intramuscularly died. These results, together with the data demonstrating that the RVFV genes are indeed inserted in the CPV thymidine kinase gene and are functioning as predicted, indicated that the rCPV-RVFV vector was ready for testing in sheep. The vector was expanded in tissue culture and used to inoculate sheep that tested negative for antibodies to CPV and to RVFV using ELISA and virus neutralization tests. Sheep in the group immunized with the rCPV-RVFV vector developed low-levels of neutralizing antibody to RVFV and the control group immunized with a control vector lacking RVFV genes did not develop neutralizing antibodies to RVFV. When these two groups of sheep were challenged with RVFV, the control group had a temperature reaction, developed a painful swelling at the inoculation site and had an RVFV viremia. The group of sheep immunized with rCPV-RVFV and challenged with RVFV did not have any evidence of RVFV, including no-temperature reaction, no painful swelling and no viremia. Two other groups of sheep were also studied. One was inoculated with rCPV-RVFV and one with saline solution. When these two groups were challenged with CPV, the saline solution control group had a temperature reaction and developed a painful swelling at the inoculation site. The group immunized with rCPV-RVFV and challenged with CPV did not have any evidence of CPV, including no temperature reaction and no painful swelling at the inoculation site. These observations are being prepared for publication and together they demonstrate that rCPV-RVFV is a bivalent recombinant virus vectored vaccine which will induce immunity against challenge with either CPV or RVFV. When available, other foreign genes can be added to this vaccine, extending the valance. Other studies need to be done with this vaccine including an assessment of the duration of the immunity induced so as to determine if and when other boosters may be required.

Activity: Evaluate protective immunity in goats induced by a new recombinant vaccinia virus expressing the *Haemonchus contortus* gut microvillar surface proteins designated GA1.

Problem statement and approach

Haemonchosis affects most goats and sheep in the world and in tropical and subtropical countries, it causes severe disease requiring expensive and regular drug treatment. A vaccine for haemonchosis would be of significant benefit to small ruminant owners, a benefit that would be enhanced by its inclusion in a multivalent vaccine. Our immunization trials using parasite gut homogenate to immunize young goats resulted in a significant protective immune response against *H. contortus* larvae challenge. A likely explanation for these results is that the parasite ingests antibody and immune cells as it feeds on blood and that these immune components kill or injure the worm. We described immunization with isolated gut proteins in a previous report and the protection obtained was considered to be moderate, although very significant because the results identified specific gut surface antigens that induced protection against a blood-sucking nematode parasite. These proteins included 46, 52, and 100 kDa proteins that were designated GA1. The gene encoding these proteins was isolated and sequenced. The gene sequence included an open reading frame that encoded the 100 kDa protein that contained the sequence for the 46 and 52 kDa proteins. The approach was to see if a recombinant vector expressing GA1 would induce a protective immune response in goats.

Progress

This activity was completed and the results reported in our annual report for 1996. In summary, goats were injected with plasmid DNA constructed to express the GA1 gene and boosted in the same way one month later. After the second injection, the DNA injected goats and control goats were challenged with *H. contortus* larvae. The two groups were evaluated by determining fecal egg counts between 20 and 35 days after challenge and by counting worms in the abomasum on day 36. There was no significant protection against challenge in the DNA immunized group. Since the isolated native GA1 protein causes significant protection against challenge, the results with DNA immunization indicate that we still need to find a practical way to use the GA1 protein for immunization. If possible, the gene should be inserted into CPV and tested in the same way as the RVFV genes were tested for activity.

Activity: Evaluate effective strategies for control of goat diseases in the coastal region of Kenya and other places selected for impact assessment of the Kenya Dual Purpose Goat (KDPG).

Problem statement and approach

Even though there is considerable information published on the ways to control infectious diseases, most of the vaccines, drugs and management options are not available to smallholder farmers in Kenya. Endoparasitic and ectoparasitic diseases of small ruminants are a major constraint to efficient goat production in many parts of Kenya. In the Coast Province and also in Katumani which is in the Eastern Province, the approach to alleviation of animal health constraints was designed in such a way that the farmers had maximum involvement in animal health care from the start and this was done to ensure a sustainable multiplication of the KDPG on-farm. In both sites, the diseases and conditions affecting small ruminants were identified during participatory rapid appraisals (PRA), as trypanosomosis, enterotoxemia, coccidiosis, abortions, pneumonia, tick-infestation, internal parasites and heartwater.

Progress

In the Kwale region where a handspray pump for acaricides was provided by the project, the group of farmers entrusted the upkeep of the pump to one lead farmer. Other farmers used the pump and paid a nominal fee that was used to maintain and repair the pump. Through formation of farmer networks in the area, about 50% of the funds realized from the sale of bucklings was placed in a community account and was used to purchase acaricides, anthelmintics and other veterinary drugs. In this area, tick and worm infestations on KDPGs and other local goats was minimal. The inputs from animal health assistants and field veterinarians contributed immensely to the improved animal health management and this has drastically reduced mortality especially in KDPG kids to below 1% during the period September 1996 to August 1997. Previously, the mortality rates for adult does was at 67% and 33% for kids. In Kilifi, the mortality for KDPG kids was less than 10% compared to the previous 22%; and in Machakos, the mortality for the KDPG kids was less than 15%, down from 45%.

The improvements in the population growth in Kilifi and Machakos has resulted from improved animal health management, while in Kilifi the use of trypanocides has reduced the problems attributed to trypanosomosis. In two of the areas, Kilifi and Machakos, networking of farmers to accumulate money for buying drugs as was done in Kwale, has been slow even with high expectations among the farmers. In all the regions, the current causes of mortality and other losses of kids are now attributed to pneumonia, snake bites, predation by wild dogs and accidents. As of June 1997, these studies involved 42 farmers and 112 KDPGs. Overall, it seems the farmers learned from the field assistants, government veterinarians and SR-CRSP scientists and improved the health of goats on their farms, especially for KDPGs born on-farm.

Activity: Conduct a field trial using the lyophilized contagious caprine pleuropneumonia (CCPP) vaccine and a field evaluation of the latex agglutination test for serodiagnosis.

Problem statement and approach

Even though over one million doses of CCPP vaccine have been distributed in Kenya, there is still a demand by farmers

Study sites	Kajiado, Narok and Baringo Districts.
Goats	970 goats eartagged and bled for serum.
Other site	Koibatek and East Pokot Districts
Goats	502 goats eartagged and bled for serum.

Tests in both sites: Latex Agglutination Test (LAT) for *Mycoplasma capricolum* subsp*capripneumoniae* (MccF38).

Table 1: Field studies of the vaccine to Mycoplasma capricolum subsp capripneumoniae

for the vaccine which has not been met. Since the vaccine has not been tested in a large field trial, it was our plan to do such a trial. It was anticipated that data from such a trial could provide the incentive for greater vaccine production by private companies or government agencies in the various countries where the disease occurs.

Progress

Studies on the field evaluation of the protective efficacy of the lyophilized vaccine to *Mycoplasma capricolum* subsp *capripneumoniae* (MccF38) were started in October 1995 in collaboration with staff from the Kenya Veterinary Vaccine Production Institute (Drs. Litamoi and Wachira).

The number of CCPP sero-positive goats varied in different regions. Approximately 50% of the sero-negative goats in each herd were given 1.0 ml of the reconstituted CCPP vaccine subcutaneously, while the other 50% of sero-negative goats were sham vaccinated and used as control groups. In all the regions, the goats were monitored for sero-conversion and also for clinical CCPP every two months. During the course of the experiment, several outbreaks of CCPP were reported in goat herds from farms in all the regions, but no active cases of CCPP were observed in the experimental goats. In the control groups, seroconversion to CCPP was detected as shown in Tables 2 and 3. However, no deaths were reported, and therefore the goats that seroconverted probably had mild infections not detectable by the farmers and not warranting intervention.

Farms	Baringo (n=264)		Narok (n=299)		Kajiado (n=407)	
	Lodogis in Baringo	Kigen in Baringo	Pulei in Narok	Shonko in Narok	Tomosian in Kajiado	Tarimo in Kajiado
goats vaccinated	71	37	41	48	50	104
goats controls	61	41	37	35	36	81
% controls that sero-converted	18%	20%	19%	9%	6%	7%

Table 2: Field evaluation of CCPP vaccine in Baringo, Narok and Kajiado Districts

Farms	Koibatek (n=240)		East Pokot (n=262)			
	Chepyegon in Koibatek	Kibon in Koibatek	Belion in E. Pokot	Lolim in E. Pokot	Kasitot in E. Pokot	Kamket in E. Pokot
goats vaccinated	42	61	26	14	32	6
goats controls	61	57	21	32	42	46
% controls that sero-converted	10%	7%	10%	6%	19%	4%

Table 3: Field evaluation of ccpp vaccine in Koibatek and Teast Pokot Districts

Table 4: Evaluation of the Latex Agglutination Test (LAT)

District	Samples collected	Percent LAT positive
Kajiado	407	52
Narok	299	14
Baringo	264	20
Koibatek	240	5
East Pokot	262	16
Thika	592	14
Moyale	195	3

The LAT positive goats in Table 4 excludes control goats that secoconverted during the evaluation of the CCPP vaccine.

Activity: Clone and express vaccine genes from Nairobi sheep disease virus (NSDV).

Problem statement and approach

Our goal with regard to Nairobi sheep disease virus (NSDV), was to prepare and characterize the M segment of the virus for inclusion in the capripoxvirus-vectored multivalent vaccine. NSDV is a member of the bunyavirus group of negative strand, segmented RNA viruses. The necessary first steps have been completed: 1) development of a cell culture system for propagation of the virus, 2) characterization of the structural proteins of the virus, including the glycoproteins encoded by the M segment, 3) purification of the viral nucleocapsid and RNA, and 4) separation of the viral segments by electrophoresis. The research aim during this period was to make a cDNA clone of the NSDV M segment.

Progress

During this reporting period, cDNA libraries of the NSDV genome and the viral M segment RNA were made in phage (lambda gt 11). Screening of the plaques for NSDV inserts was done using blue/white selection for recombinant plaques. Over 80% of the plaques screened contained a cDNA insert. DNA was isolated from selected white plaques and then amplified by PCR using lambda gt 11 forward and reverse primers. Clones containing recombinant cDNAs of sizes ranging from 0.5 kb to 2.8 kb were identified. Further characterization of the recombinant plaques from these libraries is needed to identify those containing cDNA copies of the NSDV M segment RNA, particularly those expressing protein products from this gene.

Activity: Begin to regionalize the CCPP vaccine and diagnostic test to Tanzania and Uganda.

Problem statement and approach

The plan was to initiate this activity through a trip to these countries by Fred Rurangirwa who was the primary SR-CRSP investigator in the development of the CCPP vaccine and diagnostic test. He also has worked as an FAO consultant at the veterinary research laboratories in Tanzania and is very familiar with the veterinary research laboratories in Uganda. The regionalization efforts were to be followed up with trips to those countries by Dr. Shompole to continue the transfer of technology and to continue making plans for participation in a full proposal.

Progress

Dr. Rurangirwa traveled to planning meetings for the full proposal and was able to visit potential work sites in Uganda. Dr. Shompole was able to visit several potential work sites in both Tanzania and Uganda. In discussions with these SR-CRSP animal health component scientists and scientists from Selian Agricultural Research Institute (SARI) Arusha in Tanzania and the National Agricultural Research Organization (NARO) Uganda, specific areas of collaboration were identified. In Tanzania and Uganda, there is a strong need to identify the strain of *Mycoplasma* causing pneumonia in goats and this can be done using reagents developed by the Kenya SR-CRSP, after which the CCPP vaccine can be recommended for use in the respective countries. The identified collaborative projects would blend with the plans in the full proposal to develop effective animal health management strategies for sites in those countries.

Activity: Participate in the team building for a full proposal.

Problem statement and approach

This effort will begin with an attempt to regionalize some of the technology developed through previous SR-CRSP research. This will be followed by participation with other potential team members in meetings and with other methods of contact to define an integrated program and to identify the collaborators and collaborating agencies in the East African region. The plan will be to use the knowledge gained from previous research in animal health and in dealing with the delivery of health care to low-resource farmers to interface with the overall project to insure that animal health constraints do not jeopardize the animal production systems being studied. In many cases this will involve the testing or application of existing knowledge while in other cases new problems will be identified that require research to obtain an effective solution. In the latter cases, it may be necessary to seek other funds and enhance collaboration with institutions such as ILRI to accomplish the defined research.

Progress

Investigators at Washington State University and their Resident Scientist in Kenya were participants in meetings, site evaluations and other efforts resulting in a full proposal led by Dr. Corinne Valdivia, University of Missouri, that is now being reviewed. Investigators at Colorado State University and their Resident Scientist in Kenya were participants with an Assessment Team that also resulted in a full proposal that is now being reviewed.

Training

All training involved a degree candidate and there was no non-degree training in this year. Reuben Soi is a Ph.D. candidate in the WSU Department of Veterinary Microbiology and Pathology. He completed his research in Kenya with his salary being paid by KARI. Our SR-CRSP project paid his research costs because he is a KARI collaborator and is working on the rCPV-RVFV vaccine construction and testing. His research is complete and he is working on manuscripts for his thesis.

Environmental Impact and Relevance

The principal impact that multivalent virus-vectored vaccines can make on the environment is to make small ruminant production more efficient. Use of effective vaccines should reduce the number of animals needed to produce the required amount of milk, meat and fiber.

Agricultural Sustainability

It is difficult for small ruminant production to be sustainable if deaths and production losses due to diseases exceed a fairly low threshold. By developing vaccines and diagnostic tests that can be used to decrease losses due to diseases, their application could result in a decrease in the number of animals required by individual farmers to sustain current levels of production. SR-CRSP has continued close collaboration with Kenya institutions involved in animal disease diagnosis and control including the Kenya Agricultural Research Institute, the Ministry of Agriculture, Livestock Development and Marketing, the International Livestock Research Institute, and the University of Nairobi Veterinary School. By developing an inexpensive, reliable and effective multivalent virus-vectored vaccine for sheep and goats, the project aims at improving production of small ruminants in Africa and other parts of the world.

Contributions to U.S. Agriculture

A primary contribution of this research to US agriculture is in the area of haemonchosis research. Research on vaccines for *H. contortus* has a similar benefit for US producers as it does for other countries. In addition, SR-CRSP has funded research over several years on ovine and caprine retrovirus-induced diseases (OvLV, OPC, CAE) that are of considerable economic importance to US agriculture. Results from this research have provided diagnostic tests and information for vaccine development.

Contributions to Host Country

Contributions of this project to the host county are in degree training for host country scientists, developing research facilities, seeking vaccines for diseases of small ruminants that occur in several countries including the host country, and assisting the host country in developing related projects. Virus vectors are of interest to ILRI, Nairobi, Kenya. Scientists from ILRI have been collaborating with us on the CPV vector development. Also, scientists from ILRI have participated in the training of SR-CRSP graduate students.

Support for Free Markets and Broadbased Economic Growth

If effective vaccines are developed they should be made and distributed by private companies in the countries in which they are used.

Contributions to and Compliance with Mission Objectives

The Mission officials have stated on many occasions that they support small ruminant development in Kenya. Our research on disease control has partially enabled the accomplishment of that goal.

Concern for Individuals

This is reflected in our successful relationships with host country farmers, students, scientists and administrators.

Support for Democracy

We try to contribute to this issue by example.

Humanitarian Assistance

Our efforts have been based on the belief that training host country people is one of the long term contributions we can make to the area of humanitarian assistance. Also, improving the health of sheep and goats helps farmers with small land holdings.

Collaborating Institutions

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International Livestock Research Institute, Nairobi, Kenya

U.S. Army Medical Research Institute of Infectious Diseases, Frederick, MD

Dept. of Microbiology, University of Cape Town, Republic of South Africa

Comments

The SR-CRSP research on Nairobi sheep disease, haemonchosis, and ovine lentiviruses has been enhanced by grants from other agencies. The Nairobi sheep disease has additional support from a 3-year PSTC grant to develop a diagnostic test based on monoclonal antibodies and recombinant antigens. Haemonchosis research also has support from a USDA competitive grant and the ovine lentivirus research also has support from USDA and NIH competitive grants.

Collaborating Personnel

United States

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Fred R. Rurangirwa, WSU

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Drs. J. Smith and C. Schmaljohn, USAMRID, Frederick MD

Kenya

Ruben Soi, Scientist, Kenya Agricultural Research Institute

Sankale P. Shompole, WSU Resident Scientist in Nairobi, Seconded from the Kenya Agricultural Research Institute, SR-CRSP

Paul Rwambo, CSU Resident Scientist in Nairobi, SR-CRSP

C. Ndiritu, Director, Kenya Agricultural Research Institute, Nairobi, Kenya

J.S. Wafula, Assistant Director (Animal Health)/KARI

Publications (published since the last reporting period)

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BREEDING A GENETICALLY IMPROVED DUAL PURPOSE GOAT ADAPTED FOR PRODUCTION IN KENYA

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NARRATIVE SUMMARY

During the 18th year of the SR-CRSP KDPG project in Kenya, the breeding of the KDPG emphasized the sustainability of the breeding herd beyond the CRSP and the consolidation of the KDPG at Ol'Magogo for both local and regional markets. The flock is expected to be the source of quality, pedigreed goats to be distributed to collaborating local and regional farmers. The breeding farm is expected to continue supporting a sizable flock of goats to allow for selection for growth, milk production and resistance to *Haemonchus contortus*. Feed resource development continued with the objective of achieving self-sufficiency in supplemental feed for the breeding herd through different seasons.

Due to a severe drought experienced early in the year (September '96 to April '97) combined with an orf vaccine failure, screening for endoparasites was adversely affected. A total of 50 weaners are now on schedule for screening. The screening will be a continuous exercise to characterize and select for resilience of the emerging breed to endoparasites, the major parasite of concern being *Haemonchus contortus*. Breeding for resistance is expected to reduce the reliance on anthelmintics and thus reduce the likelihood of the emergence of worms resistant to the drugs.

The KDPG is a registered breed and is currently being placed in the hands of private breeders using a hierarchical breeding structure model. This model has a small, elite breeding herd at its top that is managed by KARI. The role of the elite herd will be to continue to collect detailed production and adaptability data in view of characterizing and stabilizing the new breed and to provide pedigreed quality goats to the national and regional farmers. The privatization of KDPG breeding will continue to be emphasized. A total of 136 KDPG are in the possession of private breeding herds in Kenya. A proposal to extend the privatization of the KDPG to the East African region has been made. The on-farm impact assessment research concentrating on the economic performance of the KDPG in small-scale families at Katumani, Kilifi and Kwale districts has demonstrated a positive economic impact and the emerging role of goat breeding at the clusters.

In this transition year, the KDPG has been proposed to the new CRSP as a

vehicle of extension of the SR-CRSP DPG technologies in the East African region in the continuation proposal entitled " Negotiating Transitions: Small Ruminant Technologies For Zones Under Pressure In East Africa." The proposal specifically addresses the use of livestock, especially the KDPG, in East Africa to enable resource poor households in mixed crop livestock systems to cope with stress and enter into the monetary economy.

RESEARCH

Activity: Establishment of a Self-Sustaining Nucleus Flock of KDPG at Ol'Magogo.

Problem Statement and Approach

In the phase-out period of the KDPG Breeding project in Kenya, work at the Ol'Magogo estate has focused on the production of advanced generations of KDPG with selection for growth, milk production and resistance to the gastrointestinal tract parasite *Haemonchus contortus*. The flock is downsizing through the culling of F_1 animals and the distribution of KDPGs to collaborating multipliers. The flock at Ol'Magogo will ultimately provide an elite nucleus flock for the provision of elite bucks to the registered sector. Flock development has also focused on the development of feed resources at Ol'Magogo with the objective of achieving economic self-sufficiency.

Table 1: Distribution of genotypes at Ol/ Magoga

	August 1997		
	EA/Galla	F_1	KDPG
Does	0	0	353
Bucks	0	0	157
Total	0	0	510

Progress

The focus for the 18th year of the SR-CRSP Breeding project has been to produce an all-four way composite goat population. The third generation (from base four-ways) composite is now being produced. Culling this year emphasized the disposal of the remaining F_1 crosses and distribution of excess KDPG bucks to collaborating farmers. To attain self-sufficiency in supplementation during the drought and experimental times, a forage resource is important.

Table 1 gives the current inventory of the animals at Ol'Magogo. The table reflects the completion of culling of purebred and F_1 animals. The most advanced generation of the four-way cross is the third generation. Only one mating season was possible this year due to the severe drought. The kidding season is expected to start at the end of September 1997 and to continue through January 1998 with 280 pregnant does expected to kid. Currently there are 101 and 50 registered female and male foundation stock respectively; and 20 and 15 intermediates females and males respectively.

The culling of the DPGs has mainly benefited small scale farmers sponsored by the Catholic Diocese of Nakuru, Heifer Project International goat projects and individual farmers. Data collection has been a continuous process allowing for the continued elucidation of the genetic bases of growth, reproduction, lactation performance and strategies of helminthiasis control.

Due to a severe drought and orf vaccine failure, the *Haemonchus* challenge experiments were suspended. A group of 50 weaners is now ready for challenge. A study conducted at Ol'Magogo on anthelmintic trials indicate that there is a high prevalence of resistant worms in goats due to frequent anthelmintic treatments performed during the year to reduce losses. The frequent treatment is due to the prevailing climatic conditions which maintain a virtually continuous cycle of infection between the pasture and the host and the poor ability of goats to regulate gastrointestinal nematode infections. A strategic drenching is being encouraged with drug combinations and utilization of bucks identified as resilient to *Haemonchus contortus* through artificial infections. A flock of 16 KDPG has been characterized as resilient. This is an important strategy in ensuring the sustainability of the KDPG breeding flock at Ol'Magogo at a reduced cost of maintenance.

The Ol'Magogo farm where the KDPG breeding occurs is situated in a semi-humid to semi-arid agro-climatological zone. Hot and dry weather conditions predominant. Rainfall is unevenly distributed over the year. Rainy and relatively cold weather conditions prevail during the period March to May while August to November may be regarded as the short rains season. The highest mean monthly rainfall of 107 mm occurs in April and the lowest average rainfall of 26 mm occurs in January. A vast area of the Ol'Magogo range is under permanent pastures which consists of the natural grasses indigenous to the area. The availability of grazing land is competitive due to the presence of both large and small ruminants. The breeding project has relied on purchased commercial feeds to supplement the herd of goats. These supplementary feeds include alfalfa hay, dairy meal (energy concentrate) and weaner pellets (milk replacer). The provision of supplementary feed is limited to particular groups of goats such as does-in-milk, breeding bucks which are held indoors, kids between one-month and four-months of age, sick animals in the isolation pens, and breeding does during mating and drought seasons. This is done in order to achieve a greater efficiency in feed utilization than distributing the limited resources equally over the entire herd. Buying-in of supplementary feeds raises the cost of maintenance of the goats and makes the breeding activity very vulnerable to drought which is a frequent phenomenon around this region and thus cannot be sustained. On farm forage resource development is important in ensuring the continuation and long-term breeding of the Kenya Dual Purpose Goat at Ol'Magogo and began to be developed at Ol'Magogo in September 1995.

The sustainability of the elite nucleus will depend on maintenance of good reproductive rates which will ensure that adequate selection pressure is applied on the flock and hence allow the release of quality pedigreed animals to farmers. Level of nutrition has been shown to influence the ovulation rate, onset of puberty, kidding rate, postpartum interval to estrus, kidding interval and kid mortality all of which influence the reproductive efficiency of the herd. Data collected at Ol'Magogo indicate higher survival rates for kids born during the wet season which means mating during the dry season. Mating during the dry season is difficult with most does in poor body condition. The body condition can be improved through strategic supplementation using a less expensive and reliable source of forage.

A 150 bale alfalfa plot has been well established with a first cutting in May 1997. The alfalfa is mainly rain fed with minimal irrigation during the height of dry weather. The alfalfa hay is processed by baling or grinding to make a whole lucerne meal and stored during the wet season. An acre of wheat was harvested and processed for supplementing the lactating flock during the dry season to prevent loss of body condition. A plot of sorghum is awaiting harvesting.

Activity: Multiplication, privatization, technology transfer, and impact assessment of the KDPG distributed to smallholder farmers at the coastal and Katumani sites. Identification of collaborating farmers and distribution of KDPG to initiate the privatization of the KDPG multiplication process.

Problem Statement and Approach

The primary objective of transferring the KDPG to private producers is to ensure the rapid multiplication and provision of KDPG to small scale farmers. The process aims at expanding the source of quality, pedigree breeding goats and encourages the recruitment of private farmers into the business of registered breeding. The participating farmers have already been sensitized to the large national and regional market potentially available through their participation in the new CRSP proposal to regionalize the KDPG and its support technologies. The private breeding farms are an integral part of a three-tiered hierarchical structure forming the link between a self-sustaining elite nucleus herd owned by KARI and KDPG producers. The genetic dissemination occurs through males and females selected from the elite herd and used in the private farms. The flow is unidirectional and the elite herd is maintained as a closed nucleus. The role of the nucleus is to accumulate data on growth, reproduction, lactation and survival traits; evaluate individual animals for genetic merit for these traits for the optimization and stabilization of the breed; and the release of pedigreed breeding animals to the private sector. The private breeders act as multipliers of the elite foundation flock germplasm, and selected individuals are distributed to the producers. The KDPG stud breeders will provide additional sources of animals for the benefit of small scale producers. A close collaboration with these private breeders is maintained to ensure a smooth transfer of SR-CRSP technology as stipulated in the Memorandum of Understanding.

Progress

The transfer of the KDPG to the private sector for the purpose of multiplication was launched in July 1996 with the approval of the KARI Board of Management (MIN/BM/7/1996 of the 35th Meeting on 3rd of January 1996). Three farms have entered into contract with KARI and two have had the goats since July 1996. The three farms are: Kilifi Plantations Limited, Kirathe Farms and Meruai Farms. Although Meruai have signed the contract and made a commitment to collect the goats they have not been able to do so due to the severe drought in the early part of this year which delayed their forage development plans. The two farms with animals are part of the new CRSP proposal. Recruitment of a fourth breeder located in the dryland region of Katumani is underway.

	Kilifi Plantations	Kirathe Farms Limited
Does	39	25
Bucks	17	3
Kids	34	18
Total	90	46

Table 2: Distrubution of KDPG to privatize multipliers

Cluster	Kitanga	Kimutwa	Vuga	Matuga	Kilifi
KDPG	13	19	50	10	22
Crossbred	15	10	20	5	20
Total	28	29	70	15	46

Table 3: distribution of KDPG to Impact Assessment sites

Kilifi Plantations Limited received 40 KDPG does and 17 bucks (some of which were for use in upgrading the resident 400 goats). Thirty-five percent of the does were pregnant on transfer from Ol'Magogo and sixty-five percent of the does transferred have kidded at least once. One doe had an abortion but re-bred and kidded. The twinning percentage is about 22% with a high proportion of females to males (62% females : 38% males). The average litter size is 1.25 and kid mortality is minimal. The bucklings can be sold as early as five months and the doelings retained as replacements to build up the herd to 100 does by the end of the year. The percentage increase in the flock size in the year has been approximately 60%. The average birth weight (1.6 kg) was low as compared to Ol'Magogo mainly because of the severe national drought during the kidding period which ranged between September 1996 and April 1997. The average weight at six months was 13 kg and the oldest goat born on the farm is 10 months old and weighs 20 kg. Milk production is between 1.0-1.5 kg/day/goat with a farm target of 2-2.5 kg/day/goat. The goat milk is processed and packaged on the farm. The management promises to have goats for sale by the end of 1997.

Although no detailed production data have yet been collected at Kirathe Farm, the farm made a major policy change in eliminating all local bucks and using only the KDPG bucks for both purebreeding and up-grading. The farm received three bucks and twenty-five does, of which none have died. There are 46 KDPGs currently on the farm with 18 kids born on the farm. The percentage increase in the flock size is approximately 64%. The major health hazard during the year was orf infection which led to the death of two kids born on farm. The management promises the availability of goats for sale by March of 1998, with a projected population of at least 70 KDPGs.

Table 2 shows the inventory of KDPG in the private sector as of July 1997.

Table 3 shows the estimated population of KDPGs and their crosses at Impact Assessment Sites as of June 1997.

The role of the Breeding Project in the Impact Assessment study during the year was to support the continued observation of the KDPG on farm at the various participating sites. The KDPG as an intervention has been shown to have a positive economic contribution ranging between 3% and 20% of the total household income. A majority of farmers have been using the KDPG bucks for improving the local goats with good performance evidenced by high twinning rate and faster growth rates creating a demand for the KDPG within and around the sites.

Activity: Selection for optimum milk and meat production and resistance/ resilience to *Haemonchus contortus*. Development of segregating families for *Haemonchus* resistance.

Problem Statement and Approach

A major production constraint of cattle, sheep and goats in tropical and subtropical areas is the detrimental effect of the stomach worm *Haemonchus contortus*. These effects include reduced productivity, cost of continuous treatment and dangers to smallholders handling the anthelmintics. Through field testing, this project has established that there is wide ranging variability for resistance/resilience to *Haemonchus contortus* in the genetically segregating KDPG population and that various measures of the phenotype of resistance (EPG and PCV) have a genetic basis. Since drugs have been only marginally effective for control in LDCs and there is evidence that parasites may develop resistance to these drugs, development of genetically mediated resistance or resilience in small ruminants has been recommended. If strains of resistant/ resilient goats could be identified and selected, a major constraint to production and food chain contamination could be alleviated. Further, these animals would be of considerable economic benefit to the host country as the export demand for live animals, semen and embryos would likely be great.

Progress

The severity of the drought in Kenya during the current year forced a suspension of the challenge experiments in order that goat mortalities not be encountered due to parasitism.

Activity: Regionalization of the KDPG.

Problem Statement and Approach

The transition of the SR-CRSP to a Livestock CRSP has called for a broadening of research thrusts and diversification of geographical areas. The regionalization is intended to maximize the impact of technologies developed by SR-CRSP and KARI and stimulate awareness of the potential of the KDPG for production in a variety of ecosystems to help stimulate demand for the KDPG. The breeding project has been involved actively in the development of a competitive proposal for the new CRSP and in conducting regional visits to locations where the KDPG are located.

Progress

The proposal entitled "Negotiating transitions: Small Ruminant technologies for zones under pressure in East Africa" was developed along guidelines proposed by the new CRSP panel for the Eastern African region. It proposes to use the KDPG and its supporting technologies in ensuring food security and economic progress for the resource poor households in selected rural areas of East Africa covering Tanzania, Uganda and Kenya. The

Breeding Project contribution included participation in concept paper development, visits to Tanzania, Uganda and Kenya to identify and evaluate sites and potential collaborators. During the visit to Uganda the performance of the KDPG bucks imported by the Busoga Diocese was evaluated. The KDPG had survived well with minimal problems following a quarantine period of nine months during which the feeding habits, disease susceptibility, response to reduced feed intake and housing effects on the KDPG were assessed. The bucks are placed in four breeding centers all managed by women and on-site evaluation indicated a high incidence of multiple births and higher growth rates than for the local goats. The regional visits were followed by a two day workshop hosted by the Director of KARI. The Breeding Project was represented by the then Co-PI Dr. Francis Ruvuna and the resident scientist. The workshop identified the general objectives and activities needed for regionalization of the KDPG technologies. The final proposal has been formally submitted with Dr. Corinne Valdivia, University of Missouri-Columbia as lead PI.

The proposal recognizes the role of such assets as the KDPG in food security in small scale holdings and addresses individuals and households under economic pressure, in applying sustainable rural multiplication schemes. Identification of integrated helminth control measures will lead to further reduction of maintenance costs and enhance the survivability of goats under low input small scale holdings.

Training

The resident scientist participated in organizing on-station training sessions for farmers, NGOs, and livestock officers interested in goat husbandry. Parties benefitting from this interaction included Nakuru Diocese goat project, Laikipia District, livestock officers and a women's group from Uganda under the Mirembe Self-Help Project.

The Resident Scientist participated in the regional proposal participatory planning workshop held in Nairobi between March 20-21, 1997.

The Resident Scientist attended the Kenya Veterinary Association Scientific Conference in Kisumu between April 23-25, 1997.

Environmental Impact and Relevance

Small ruminants, and goats in particular, have unjustifiably been criticized for contributing to the degradation of much of the world's agricultural lands. Often, such degradation is due to non-sustainable human agricultural practices, such as slash and burn cropping, but when overgrazing is a contributing factor, the fault is again due to non-sustainable human management practises. Even where overgrazing is a contributing factor to degradation, critics of small ruminants must not overlook the fact that goats are usually the only livestock species that can utilize these marginal lands to convert browse to human food protein. The SR-CRSP Dual Purpose Goat component has addressed these issues in the design of the program which focuses on the integration of small ruminant and crop production in the smallholder context. The central theme of the component has been the production of a Techpac, published in English and Kiswahili, designed to present an integrated production technology to producers that will ensure that small ruminant production will enhance soil conservation and fertility rather than contribute to its degradation. The Techpac is undergoing testing in the smallholder context utilizing the KDPG on farm in the semi-arid Katumani, the tropical Kilifi and Kwale coastal regions and with the farmers participating in the privatization initiative.

Agricultural Sustainability

The Breeding Project has targeted the development of a dual-purpose goat designed to meet milk and meat components of human protein consumption within the context of a sustainable farming-systems model. This model integrates crop and restricted-grazing animal production using by-product feeding and low-tillage agriculture that incorporates animal manure as fertilizer. The Techpac is designed to ensure that the small ruminant component contributes to soil conservation and fertility rather than allowing degradation due to human allowance of overgrazing. Research into *Haemonchus* resistance has a major objective of reducing producer dependency on chemicals for parasite control.

Contributions to U.S. Agriculture

The genetic studies on *Haemonchus contortus* are of importance to the U.S. due to the cost of production losses and due to the increasing importance of parasite resistance to chemotherapy. Resistant bucks have now been extensively used in the breeding herd at Ol'Magogo and this resource herd provides a useful resource for future research.

The Breeding project has developed 27 polymorphic caprine microsatellite markers which are published, or in press, and are available to other U.S. researchers.

Contributions to Host Country

Linkage and Networking

An Impact Assessment project involving Heifer Project International, KARI, MALDM and all of the Kenya projects continues to evaluate the potential of the KDPG to benefit smallholder farmers.

The PIs, RSs and representatives of KARI and MALDM are well advanced in the privatization of the multiplication of the KDPG.

Collaboration with IARCS and other CRSPs

The PI has exchanged DNA samples with Dr. Olivier Hanotte of ILRI to assist in his study of African biodiversity.

Support for Free Markets and Broadbased Economic Growth

The project continues to collaborate with HPI in the implementation of the KDPG Impact Assessment study. This study follows a model of privatization and decentralization for the multiplication and distribution of the KDPG.

Contributions to and Compliance with Mission Objectives

Consultations with the USAID/K Mission ensure that the design and implementation of the multiplication and distribution phase of the KDPG Breeding project is in accordance with Mission objectives.

Concern for Individuals

The major contribution of the Breeding project indicative of a concern for individuals is the commitment of the project to training to provide a mechanism for life-long advancement. The project continues to support the research of Dr. R.M. Waruiru, a faculty member at the University of Nairobi, through collaborative research regarding the genetics of *Haemonchus* resistance.

Support for Democracy

The model selected for the multiplication of the KDPG is to utilize private breeders as the primary source of supply of the KDPG to smallholders. This model supports the concept of privatization and free trade inherent to the democratic principle.

Humanitarian Assistance

In collaboration with HPI, 51 smallholder families continue to benefit from receiving KDPG does and technical training through the distribution of KDPGs in the Impact Assessment study.

Two private Kenya farms have now received the KDPG to facilitate the privatization of the KDPG multiplication program. These farms will provide KDPGs to the Kenya private sector.

Collaborating Personnel

United States

Scott K. Davis, Associate Professor, TAES.

Francis Ruvuna, Associate Professor, Alabama A&M University.

Kenya

Joseph Kogi, Resident Scientist, KARI.

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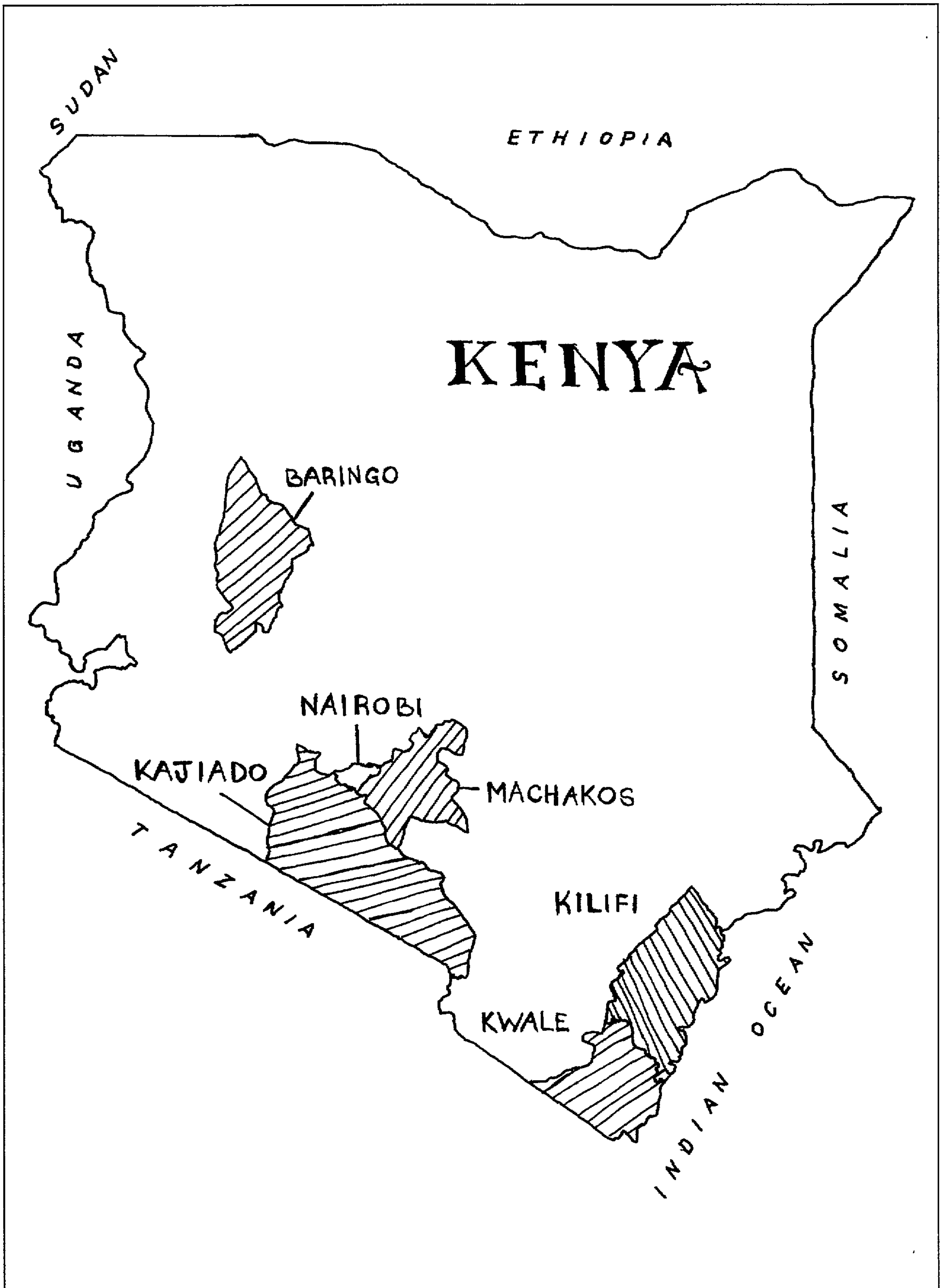
SUDAN
ETHIOPIA
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TANZANIA
KILIFI
KWALE
INDIAN OCEAN

Dual Purpose Goat Production Systems for Smallholder Agriculturalists in Kenya

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Narrative Summary

This report will cover results that have not been reported in the past and highlights of activities towards Livestock-CRSP. However, as we look to the past and into the future the overall objective of the Production Systems Project (PSP) continues to be, client oriented research on developing, evaluating, and promoting dual-purpose goat production systems based on low-cost and low-risk technology packages for enhancing dietary and financial well being of rural families.

Data management and analysis of on-farm monitoring research was conducted throughout the year to provide insights on the preferred forage species, dry matter intake, frequency of watering, management strategies, tethering pattern and general outlook of the KDPGs as perceived by the smallholders. Also information gathered from model farms was analysed and results of the on-station model farm will be presented in this report.

While the Animal Health Project (AHP) tested the thermal stable vaccine in different production systems, PSP monitored system changes and potential management alternatives. Participatory rural appraisals were conducted to supplement monitoring research in describing production systems and identifying constraints interventions and opportunities. Since preliminary results of this activity have been reported in previous reports, it will be deferred for the final.

During the year PSP was engaged in regionalization of the KDPG technologies. It was instrumental in making initial contacts and it conducted a successful Participatory Rural Appraisal (PRA) in Masaka, Uganda. Results of the PRA are reported below.

Research

On-station model farm

Introduction

The inter-relationships between components of livestock production (feed, health, breed etc.) and the competition for resources with crops necessitates that the demands of any new technology be thoroughly understood, and conflicts that it might cause in the existing system sorted out before dissemination. This is best done at two levels on-station and on-farm. The on-station simulates farmers capital resources and on-farm ensures timely implementation of interventions. Model farms also serve to demonstrate their potential for income generation and give indications for possible credit to facilitate adoption of technologies.

Previous surveys in the lower Machakos district revealed that the average land holding was 7.5 ha on which mixed farming is practiced (crop growing and livestock rearing). Of the land holding, 2.5 ha is under crop production mainly maize and beans, but also minor pulses all grown in mixtures, the rest (5 ha) is used for livestock production. The main constraints to livestock production being feed shortage, water, diseases and limited genetic potential of indigenous animals.

The Improved System

Research results at the National Dry Land Farming Research Centre, Katumani have shown that the feed resource base on smallholder farms can be greatly improved through:

- Introduction of planted forages on 1 ha of the 5 ha remaining.
- Selective bush clearing of the rest (4 ha) to increase grass growth but also retain preferred browse for goats, followed by reseeding the denuded patches.
- Proper collection and storage of crop residues from the cropped land.

Subsequently, the farmer would then gain from the above efforts on further realignment of farm enterprises:

- Introduction of cross-bred cows with high milk production potential.
- Adjustment of livestock numbers to the available feed resources.
- Maintenance of systematic disease prevention and control schedule.
- Provision of an appropriate shed and other facilities for better feeding, watering and manure collection.

Based on the feed resources developed the recommended livestock for the model farm were:

2 cross-bred dairy cows
1 replacement heifer
2 oxen (indigenous zebu)
5 sheep and their followers
5 goats and their followers

This was the mixture of livestock which met the farmer's needs for draft power, milk production (for sale and home consumption) and smallstock for meat and periodic sale to meet cash needs such as school fees.

It was within this improved system that the KDPG technology was introduced and its impact monitored for a period of one year. Two KDPG does and one buck were introduced as an added improved technology into the sub-system. Data was collected on milk production from cattle and goats, calf, lamb, and kid growth, livestock offtakes, disease occurrence and mortality, input data records of labour needs for various activities and cost prices for all items.

Results

Feed resources improvement based on forage interventions produced feed resources as shown in Table 1.

Investment and Inputs Costs

As stated earlier there were initial investment and input costs to the model farm in order to improve outputs. These

Table 1: Estimated Total Forage Resources

Type of resource	Yield t. DM ha	Total t. DM
4 ha improved rangeland	2.3	9.2
0.5 ha planted fodder	6.0	3.0
0.5 leucaena	4.0	2.0
2.5 ha crop residues	2.0	5.0
Total		19.2

are presented in Table 2. It will be noted that the cost of cross-bred dairy cows and the KDPGs are not included since they are supposed to be acquired through improved breeding (A.I. or bull for cows and through pass-on scheme for KDPGs). The major item of expenditure was the livestock shed whose cost escalated due to use of iron sheets for roofing. The farmer can improvise and use grass for thatching, however the choice of iron sheets was so as to facilitate water harvesting for both domestic and livestock use.

Labour Requirement

The daily labour requirements for management of the livestock sub-system is shown in Table 3. Over a half of the total time was taken up by herding. Substantial, but what was the opportunity cost. Herding time can be reduced through paddocking of the 4 ha under natural pastures. Effective, and lasting fencing can be achieved by use of live fence material. Fetching of water took a little time because on-station the distance to the source was 100 meters. On-farm the distance is much longer with those within a kilometer regarded as short. Time spent on the health care (i.e. dipping, drenching and treatment) is about one hour in a week. The important point to note is that the daily labour requirement is approximately 1-manday which can easily be met from the family source.

Outputs

Milk Production

The average lactation yield (Av. 315 days) from two cows was 1,638 kg per cow without the calf at foot. This production was realized under semi-zero grazing where natural pasture grazing was supplemented with napier grass during the wet season and maize stover mixed with conserved leucaena leaf meal during the dry season. Out of the total yield 450 liters was fed to each calf over a 4-month period, leaving 1,188 kg of milk per cow for sale or home consumption. At the current local price of milk of Ksh. 25/= per liter, the value of milk offtake from two cows amounted to Ksh. 59,400/= over a period of less than a year. The contribution of the two goats to milk production was not much since one of the goats dried much

Table 2: Estimated Cost of Inputs

Activity	Labour mandays	Cost (KSH)
1. Bush clearing (4.0 ha)	48	2,697
2. Establishment of Forage 0.5 ha fodder grass 0.5 ha shrub legume (planting plus 2 weedings)	75.6	4,248
3. Collection of crop residues from 2.5 ha	25	1,405
4. Drugs (Acaricides, Antibiotics, Anthelmintics etc.) for all animals		6,760
5. Mineral supplements		1,500
6. Livestock shed		10,000
7. Miscellaneous (milking utensils, wheelbarrows, drums for water, etc.)		4,000
TOTAL		**30,610**

earlier, which was not normal. The other goat produced on average 570 ml per day for 50 days giving a total production of 28.5 liters. This production level excludes milk that was suckled by the kids. The second goat produced 4.6 liters only, in 27 days. Thus the total amount of goat milk produced in the sub-system in one and a half months was 33.1 liters valued at Ksh. 827.50. A small amount but in rural Kenya it is substantial for it is more than a half of recommended labour wage.

The lactation curves for the dairy cows had a marked rise in milk production at week 32 in response to feeding of treated stover supplemented with leucaena leaf meal. The curve for goats followed the normal trend of starting at the peak followed by a steady drop until drying.

Live animal off-takes

Culling was done as shown in Table 4 to maintain carrying stocking rate equal to available feed resources. The animal offtake consisted of 5 sheep with a total of 144 kg and a value of Ksh. 5,040/= (at 35/= per kg) and 4 goats with a total of 131 kg valued at Ksh. 6,550/= (at 50/= per kg).

Table 3: Labour Requirement for Livestock Work

Activity	Hr/day
Milking (2 cows, 2 goats)	:51
Cleaning shed and transporting manure	1:22
Feeding (Harvesting, transporting, chopping and feeding)	1:50
Herding (cattle plus smallstock)	5:09
Watering (fetching and hauling water » 100m away)	:30
Total	**9:42**

Manure

An estimated 20 tonnes of manure (composite) was collected in the year from the herd. The monetary value of this manure is Ksh. 9,200.00 at the current sale price of Ksh. 460 per tonne.

Thus the total output of Ksh. 80,967/= (milk - Ksh. 60,227; sales of live animals - Ksh. 11,540 and manure Ksh. 9,200) from the system greatly outstrips the initial costs of Ksh. 30,610 and makes the investment quite attractive. The introduction of the KDPG into the system did not alter the demands at all neither did it cause any conflicts in the system, instead it made positive contribution to the income even after just one year. It is anticipated that over time this contribution would greatly increase as the indigenous breeds are improved through cross-breeding and faster growth rates are experienced.

Table 4: Live Animal Offtakes

	TagNo.	DOB	Sex	Date Culled	Culling Age	Culling Weight
Sheep	324		M	31-10-96		41.0
	303	02-06-92	F	27-11-96		25.0
	318	01-10-94	F	27-11-96		30.0
	335	16-04-96	M	27-11-96	7 months	22.0
	338	15-08-96	M	07-02-96	5 months	26.0
Goats	9386	03-09-93	M	31-10-96		51.0
	KG8	25-12-92	F	27-11-96		30.0
	779	14-01-93	F	27-11-96		30.0
	142	04-07-96	M	07-02-97	7 months	25.0

Results of Participatory Rural Appraisal: Masaka District, Uganda

Background information

Masaka District is one of over thirty nine districts in Uganda. Currently it is in the process of being sub-divided into Sembabule and Masaka (w.e.f. July 1, 1997). The headquarters of the district are located in Masaka town which is 137 km. south west of Kampala and within the Lake Crescent belt of Lake Victoria. It is said to be the fourth or fifth largest town in Uganda. During Uganda's civil wars the town suffered a lot of destruction and in peace and reconstruction it is not spared the agony of AIDS/HIV. Despite these problems Masaka residents, farmers and other stake holders have embarked in an ambitious reconstruction program of animal and crop agriculture, infrastructure and commerce and trade.

The District occupies an area of 6986 sq. km. This is approximately 3% of the total area of Uganda. It is divided in to six counties, thirty parishes and eighty circles (agricultural extension administrative units). Each circle is supposed to have a front line extension staff for advising farmers and as a link between farmers and subject specialists. Area under cultivation is approximately 122,120 hectares and annual rainfall is between 600 and 1000 mm per year. Human population is 834,631 with a density of 119 persons per sq. km. Total number of farm-families in the District is 139,105 (1993).

Crops: The main crops are banana, coffee, beans, maize and cassava. Banana as the staple crop is grown widely. The District is a good reflection of Uganda as described by Winstonne Churchill (1908). "Uganda is from end to end one beautiful garden, where the staple food of the people grows almost without labour. Does it not sound like paradise on earth. It is the pearl of Africa."

Livestock population in Masaka District is shown in Table 5.

By population size cattle are the most important followed by goats. Roughly each farm-family has 0.7, 0.2, 1.5 and 0.3 of a goat, sheep, cattle and pig respectively. It is noteworthy Masaka has more pigs than sheep. In many other districts in the region it is the reverse.

There are three production systems namely, extensive, semi-intensive and intensive. Extensive production of ranching is practiced in half of the District. In this production system livestock are free ranged. In semi-intensive livestock are tethered. While in

Table 5: Livestock Population in Masaka District (1993)

County	Goats	Sheep	Cattle	Pigs
Bukuto East	7749	1759	15225	6349
Bukoto West	24157	2063	32321	5973
Bukomansimbi	10800	1674	9719	13507
Kalungu	13606	7508	17206	7751
Mawogola	29247	13506	67666	3748
Lwemiyaga	14671	1247	63263	475
Total	100230	27757	205400	37623

Source: SMS/Animal Production Report 1996.

intensive they are confined necessitating "cut and carry" management.

Breeds of goats: There are three indigenous breeds of goats in Masaka. According to Mason and Maule (1960) they are East African Goat (EAG), Mubende and Kigezi. The latter two have further been described and characterized by Sacker and Trail (1966) and Okello (1985).

Saanens, Toggenburgs and Boers have been introduced in the District, the first two for milk and the last for meat production. Within the District various crosses of these exotic breeds were encountered.

Feed resources: Consists mainly of Pennisetum spp, Bracharia brizantha, Hyparrhenia spp, Panicum maximum and a variety of leguminous species. For a few farmers to supplement natural grazing are growing Chloris gayana, Stylosanthes spp, Desmodium spp, Siratro spp and multi-purpose trees (MPTs). Integration of animal and crop agriculture is evident in utilization of dual purpose and crop residues. However, the feeding of crop residues and agro-industrial products is done whenever available. Main concern is feed shortages and nutrient deficiencies in dry seasons.

Results of PRA

Conducted in Busense Village, the PRA was attended by Uganda National Farmers Association special interest group (SIG). This goat SIG with fifteen members was formed in 1996. Busense Village is 15 km South of Masaka.

1. Farm size 2 to 5 acres

2. Goat flock size 1 to 5 head per farm

3. Goats are raised for meat, manure and security against emergencies e.g. school and medical fees. Lately they have learned of milk goats with great interest. This interest prompted formation of SIG for acquisition of milk goats. Recently they bought a Saanen Toggenburg cross from Joy Children Centre. The members are sharing the buck and are in desperate need for more quality bucks and does. In the past few years goats have acquired a new role of the animal to be sold to raise money to pay graduated income tax. The tax is approximately equal to the value of a 2-year old goat which is UShs. 20,000.00.

4. Preference ranking of livestock species by women: 1. cattle 2. chicken 3. goat 4. sheep. Men differed on whether it is chicken before goats or vice versa. Women ranked chicken second because of eggs output. They hinted on goats taking the second position on production of milk. Currently they own meat goats.

5. Weather pattern:

- Two dry seasons Jan./Feb. and July to Sept.
- Coldest month July
- Hottest months December and January
- Rainfall throughout the year but heaviest in April and May.

6. Division of labour (goats): Women- mostly involved in feeding and cleaning where goats sleep. For many farmers their goats sleep in kitchens. Men- treatment of goats and other animals plus selling,

making tethering ropes and cutting and carrying fodder.

7. Health management: Veterinary drugs are considered to be too expensive for many farmers. Therefore they are bought or help is sought when diseases are obvious and advanced. If money is not available they go for local herbs. Diseases treated include helminthiasis (black and red seeds from a tree to be identified) pneumonia (boiled extracts of Lantana camara and guava leaves) and mange (washing affected areas with omo) among others. Misuse of drugs, under dosage and adulteration is creeping in. Is catalyzed by liberalization of the pharmaceutical trade coupled with poor enforcement of standards.

8. Feed resources inventory: Pennisetum purpureum, Pennisetum clandestinum, Bracharia spp., Hyparrhenia spp., Panicum maximum, indigenous legumes and shrubs, Lantana camara, Artocarpus heterophyllus, recently introduced MPTs, maize stover, cassava, bean haulms, banana leaves and peels and sweet potato leaves and vines. The inventory list is much longer than above. This list came from the PRA exercise and observations during our 5-hour stay in Busense. Concentrates are available but farmers are weary of quality, due to the problem cited above of enforcement of standards.

9. Results of pairwise ranked goat production constraints

1. Appropriate goat house
2. High cost of drugs
3. Worms
4. Feed shortage
5. Pneumonia
6. Orf
7. Mange

10. Problem analysis

Constraint: Lack of appropriate goat house. An appropriate house is a low cost one that can also serve for total confinement (zero grazing) and facilitates collection of faeces for manure.

Coping strategies:
a) Goats are housed in kitchens
b) Some farmers have partitioned their kitchens
c) Some farmers have built goat houses

Opportunities:
a) Credit for construction
b) Introduce appropriate designs requiring minimum bought-in materials.
c) Remove or debud bucklings early

Constraint: High cost of drugs. Farmers are aware of drugs and are available. Buy when it is a must or opportunistically following a good sale. Opportunistic buying and treatment is common with anthelmintics.

Coping strategies:
a) Use of local herbs
b) Sell crops to purchase drugs
c) Forced sale or slaughter

Opportunities:
a) Veterinary service on credit
b) Bulk purchase by the group or association
c) Introduction of community based delivery of veterinary and other livestock services
d) Research on local herbs

Constraint: Worms (Helminthiasis) Mean monthly temperature and rainfall of Masaka are optimal for helminthiasis.

Although farmers are aware of the bad effects of helminthiasis, they do not drench their goats routinely. This is probably due to sub-clinical symptoms and high cost of anthelmintics or both.

Coping strategies:
a) Occasional drenching

Opportunities:
a) Routine strategic drenching
b) Zero grazing
c) Wilting of fodder
d) Strategic tethering
e) Efficacy testing of anthelmintics in the market and enforcement of standards

Constraint: Feed shortage. In agricultural high potential areas with rainfall of 1000 mm or thereabout, feed shortage is a result of diminishing land for pastures in preference for staple and high value crops.

Coping strategies:
a) Utilization of crop residues
b) Capitalizing of relatives, neighbours and public land
c) Opportunistic buying of feedstuffs

Opportunities:
a) Planting fodder
b) Conservation (hay or silage)
c) Improved use of crop residues
d) Improved use of agro-industrial byproducts
e) Integration of animal and crop agriculture
f) Improved pastures

Constraint: Pneumonia. Infectious or noninfectious causes resulting in coughing (kukorora).

Coping strategies:
a) Use local herbs
b) Good care and hygiene
c) Treatment with broad spectrum antibiotics

Opportunities:
a) Appropriate housing
b) Diagnosis
c) Optimal feeding and drenching
d) Good husbandry education/ awareness

Constraint: Orf. Is a contagious disease of sheep and goats. The virus is very hardy and can live for extended periods away from the host. It is also contagious to man.

Coping strategies:
a) Use local herbs

Opportunities:
a) Spraying of sores
b) Treatment with antibiotics to prevent secondary infection.
c) Vaccination

Constraint: Mange. The two most common mites infecting goats are the scab mite (Sarcoptes) and the follicle mite (Demodex).

Coping strategies:
a) Use omo to wash affected areas.

Opportunities:
a) Dip goats
b) Use insecticides
c) Use Ivermectin

TRAINING

No degree training in progress. One 1-day PRA was conducted in Masaka, Uganda. Our KDPG farmers exhibited their goats with good results at Machakos and Mombasa agricultural shows.

Environment

Encourage use of KDPG manure instead of inorganic fertilizers
Introduced leguminous shrubs for feeding livestock that are good in nitrogen fixation
Promoted growing of appropriate grasses to hold terrace benches in soil conservation

Agricultural Sustainability

Our research has focused on integration of animal and crop agriculture (utilization of crop residues, manure, dual-purpose crops and multi-purpose trees)

Contributions to U.S. Agriculture

Technology of sweet potato vines and leaves as a milk replacer has been exported to U.S. (contact W. Getz for details).

Contributions to Host Country

A document is in preparation on the National Small Ruminant Research Programme. This document has looked at what has been achieved and what production constraints by production system are there for research. The first draft of the document will be out early next month. The PSP has promoted awareness of small ruminants as important contributors to the economy and household food security.

Collaboration with IARCs

The PSP enjoys good collaboration with ILRI. Patterson Semenye is a committee member of ILRI's African Small Ruminant Research Network (SRNET).

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ANIMAL HEALTH MANAGEMENT THROUGH BIOTECHNOLOGY COMPONENT

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NARRATIVE SUMMARY

Research activities during year 18 concentrated on completing data analysis of the case studies testing the Contagious Caprine Pleura Pneumonia (CCPP) vaccine. The case studies were useful in providing information on the farmers that are working with the SR-CRSP at different sites testing the freeze dried form of the vaccine. The sites included Ngong, Suswa, and Mogotio, in Kajiado and Koibatek. Field testing of the questionnaire of the larger demand study was conducted with these farmers. Six case studies were developed. From the analysis comparing treatment of the disease and vaccination, we concluded that the CCPP vaccine was cost effective in areas where there are frequent CCPP outbreaks, with high mortality rates. Therefore, farmers who believe this probability to be low may not be inclined to use the CCPP vaccine. All the respondents in these case studies possessed oxytetracycline and syringes, that they themselves administered to infected goats. This was their current strategy to deal with the disease. A contingent valuation question was answered in the affirmative.

The sites selected for the demand study are located in the the Rift Valley and Eastern Province, both with the largest population of goats in Kenya. Activities during year 18 concentrated on the analysis of the survey data for the first production system, and data collection and processing of an additional production system, to compare socioeconomic status, production system, and information access between the different systems. The same questionnaire was applied to all 137 households. Sixty farmers were interviewed in Koibatek, formerly part of the Baringo District, and the data processed this year. Seventy-seven households were interviewed in Kitui during 1996-1997. This was a year of drought and hunger in the area, which made it difficult to interview farmers as they were away from home, seeking other sources of income. Koibatek is characterized by large herders with an important proportion of small ruminants; goats play an important role in an area that is CCPP endemic. Kitui district data reflects a crop-livestock system with Bantu people. An important proportion of crops generate income, with smaller livestock herds than Koibatek.

We found differences within groups regarding knowledge of the vaccine. At

Koibatek the proportion of farmers who know about the vaccine is low. Both Mugurin and Koibos in Koibatek have comparable lack of knowledge ranging between 67 and 75%. The distance3 from Koibos to the nearest veterinary clinic is double that of Mugurin, the village with higher mortality and morbidity related to CCPP. Forty-five percent of the households in Kitui are aware of the existence of the vaccine; 86% are willing to pay for a vaccine at a cost ten Kenya Shillings, three times the current price for the liquid form, the estimated price of the freeze dried form. It is interesting to note that there are differences between the sites, with Ikutha in Kitui having the highest proportion of farmers willing to pay for the vaccine, though mortality and morbidity were low. The distance to market was large compared to Mutomo, where awareness of the vaccine is highest, but lower than Voo, with both the highest mortality and distance to market. Overall, Kitui is more aware of the existence of a vaccine than Koibatek. The willingness to pay for the vaccine is equally important in both districts. In the overall ranking of problem diseases in the area, Koibatek ranked CCPP number one (40% of the sample). East Coast Fever was ranked second (26%of the sample). CCPP was ranked number one by 69% of the households in goats diseases. In Kitui 25% of the households listed CCPP as their number one problem in diseases and 21% listed East Coast Fever.

Data analysis from all the sites indicates that in both agropastoral and crop-livestock systems, CCPP is perceived as a problem disease. In some areas both mortality and morbidity are high. Lack of awareness of the existence of the vaccine is an important fact, and the high willingness to pay for the insurance the vaccine provides seems to indicate that there is a potential demand for the vaccine.

Mr. Willie Njoroge was research associate of the project until August 1996. He took the lead in the field research activities. He is now working for the International Livestock Research Institute (ILRI). Ms. Sheikh and Valdivia continue the analysis of the data with multiple regression models at the University of Missouri-Columbia. The methodologies and instruments have been shared with KARI socioeconomics, under the lead of Dr. Mbabu, to conduct studies in Kajiado and Garissa. Furthur information can be found at the University of Missouri website: *http://www.ssu.missouri.edu/ssu/srcrsp.*

Research

Demand for Animal Health Services and Use at the Household Level

Problem Statement and Approach

Contagious Caprine Pleura Pneumonia (CCPP) is a disease of major economic importance in Kenya, and imposes a significant constraint upon goat production in Kenya. The F38 strain of Mycoplasma has been demonstrated to be the cause of the disease in Kenya (MacOwan and Minnete, 1976) and Sudan (Harbi et al, 1981). Research by KARI and SR-CRSP scientists contributed to the development of a vaccine against CCPP resulting from Mycoplasma strain F38. This vaccine, created and produced during the 1980's, was improved through the process of freeze drying. Freeze drying increases the shelf-life of the vaccine, and removes the necessity for cold chains which are expensive to maintain. Despite the successful production of the vaccine, and the equally successful field trials demonstrating its efficacy, levels of use and adoption of the vaccine are very low. Conventional wisdom suggests that the farmers have no interest in the vaccine. Information obtained from KEVEVAPI and the Veterinary Field Services Office indicate that the demand for this vaccine is low. The production and sales figures for this vaccine in the last five years tend to support this view. For instance, while the national goat population stands at 10.5 million (GoK, 1995), production and sales figures for the CCPP vaccine for the period 1992-1995 have never reached 200,000 doses per year (their potential capacity). This project studied the institutional constraints to the CCPP vaccine production. The present study focuses on identifying the conditions affecting the demand such as social, cultural and economic factors that explain use and adoption. The purpose is to identify the factors affecting the demand for the CCPP vaccine, by interviewing potential users of the vaccine. These are goat farmers, mainly in the arid and semi-arid areas of Kenya, where the disease is endemic.

Our working hypotheses are: a) lack of information constrains use and adoption of CCPP vaccine; and b) the cost of the vaccine is prohibitive as compared to treatment and presence of the disease.

Willingness to pay is the theoretical approach to analyze demand. This includes the use of a qualitative dependent variable (willingness to pay for the liquid form of the vaccine in the first model, and willingness to pay for the thermostable vaccine in the second). Independent explanatory variables are alternative methods of control, size and economic value of each species, cost of alternative treatment method, pattern of outbreak of the disease, literacy, distance to markets and information access indicators.

Two types of studies were conducted in 1996 and 1997; a series of case studies with the farmers participating in the animal health experiment of the freeze dried vaccine, and a study of two of the four livestock production systems that include goats. With the collaboration of the animal health project, the participating farmers were interviewed during the vaccine testing period. This allowed us to developsocio-economic profiles of the participating farmers, and provide a field testing opportunity for the larger study. Six case studies were developed. Two of the respondents are from the Mogotio division, Koibatek district (previously in Baringo district). This division is located on the southern end of Koibatek district, which is arid and semi-arid. Livestock production is the predominant enterprise for the majority of people. Three of the respondents are from Suswa, Kajiado district. Suswa is located in arid and semi-arid agro-ecological zones. Two producers live close to each other (2 km) while respondent three is 10 km away. The last respondent is from the Ngong division, Kajiado district. The three sites, Mogotio, Suswa and Ngong are important goat producers. These areas are identified by the Veterinary Field Department as CCPP endemic in Kenya.

In 1996 the selection criteria for the larger study were developed, and three production systems in semi-arid and arid areas identified. These were reduced to two because of lack of sufficient funding and time. Mr. Njoroge, our research associate took a position with ILRI in August. Until then he was in charge of the field work. The questionnaire we developed elicited information on the household production system, animal health diseases by species, services available, current approaches to treatment of diseases, economic and demographic characteristics of the households, and questions to determine the willingness to pay for CCPP vaccines developed. We tested the questionnaire with the farmers participating in the animal health project research on performance of the freeze dried form of the vaccine. The first production system selected consisted of a sample of 60 randomly selected farmers from the Koibatek/ Baringo Districts. This would describe a production system of large herders, predominantly small ruminants where goats play an important role, and in an area where CCPP has been identified as endemic. Kitui district represents the crop-livestock system with Bantu people. Kajiado, representing a system with Maasai people, is predominantly goat-cattle herds. We were not able to conduct a survey in this district, but we did conduct case studies.

In order to understand the demand for a product not yet marketed, we approached the problem with a willingness to pay perspective. The questionnaire included questions regarding the willingness to pay for the liquid and the new form of the vaccine. A qualitative dependent variable (willingness to pay for the liquid form of the vaccine in the first model, and for the thermostable vaccine in the second) is hypothesized to be the function of, or explained by alternative methods of control, size and economic value of each livestock specie, cost of alternative treatment methods and availability, pattern of outbreak of the disease, literacy and information access indicators, and distance to input purchasing and veterinary service centers.

Progress

Activities during year 18 concentrated on the analysis of the case studies, processing of the survey data of Koibatek the first production system, which included cleaning the data and developing a code book and descriptive statistics, and data collection and processing of the second district, Kitui, with 77 farmers. Production systems are compared, by applying a similar questionnaire to the households in both districts.

The Case Studies: A Socioeconomic Profile of the Households Participating in the Testing of the CCPP Thermostable Vaccine

The testing of the thermostable CCPP vaccine has been going on at three sites, Suswa and Ngong in the Kajiado district, and Mogotio in the Koibatek district. The testing of the vaccine conducted by the animal health project of the SR-CRSP aims to establish the efficacy of the lyophilized CCPP vaccine. This vaccine is an improvement on the liquid form of the vaccine, which is currently produced and marketed by the Kenya

Veterinary Vaccine Production Institute (KEVEVAPI). The impetus to produce the thermostable vaccine came from the need to have a vaccine with a longer shelf life, not requiring cold distribution chains, a necessary and expensive attribute of the current vaccine. The liquid CCPP vaccine was developed in the mid-eighties. It has been tested and proven a reliable prophylactic treatment against CCPP.

The procedure to select the participating farmers in the field testing experiment was arbitrary, in the sense that it required farmers willing to have their animals participate in the experiment. No sampling design was developed to select the owner. Their willingness to take part in the experiment was the criteria for selection, as well as choosing areas where CCPP is endemic. The six case studies are in areas known to be CCPP endemic zones which had problems with the disease at the time of the experiment. The objective of animal health research was to monitor sero conversion in both the treated and the control goats at sites plagued by the presence of Mycoplasma F38. The participating farmers in the two experimental sites are Maasai and Kalenjin; both belong to the ethnic group Nilo-Hamite. Maasai and Kalenjin are ethnically and culturally similar in that both have traditionally kept livestock, as a central activity of their socio-economic life.

Production systems and economic activities at the households.

The livestock production system at the two experimental sites may be described using the three stage procedure for developing a classification of animal production systems proposed by Carles (KARI-ODA Socio-economic project). At the first stage, the criteria to consider is the nature of the grazing system (extensive, zero grazing, etc.). The next stage is to distinguish the type of livestock kept (species and breeds), the agro-climatic zone, purpose of production and the level of input use (intensive or extensive). The third stage considers primary outputs for each of the species. Based on these criteria the production system in the case study sites is extensive, with cattle, goats and sheep, in semi-arid climate, and meat and milk as the primary products. McLeod proposed (KARI-ODA Socio-economics) a procedure that involves identifying the scale of production, the species kept, and primary output of each of the species. Based on this, the systems are livestock production system, pastoralists with goats, cattle and sheep, and the primary outputs are meat and milk.

Some land tilling activities were also found with the exception of one in Ngong. Since these are arid and semi-arid areas, rainfall is poor and unpredictable, the crop enterprise is unreliable and of secondary economic importance, but important for consumption, highlighting a central issue of food insecurity (See Valdivia, 1997)

Economic profile of participating farmers.

The livestock enterprise has been identified as the dominant activity. Tables 1 through 3 presents a summary of livestock inventories and use by respondents for 1995. Crop production for the same year is reported in Table 4.

Table 1: Goat inventory and transactions for the year 1995, all case studies.

Respondent	Number of goats owned		Number consumed in 1995	Number sold in 1995	Average price (KSH)	Income from sale of goats (KSH)
	Mature	Young				
1 Mogotio	87	16	5	8	1,465	11,720
2 Mogotio	112	28	45	55	1,500	82,500
3 Suswa	200	17	10	50	1,250	62,500
4 Suswa	113	28	60	0	-	0
5 Suswa	70	14	18	3	2,200	6,600
6 Ngong	135	70	8	60	1,700	102,000

Source: Interviews with farmers.

Table 2: Sheep inventory and transactions for the year 1995, all case studies.

Respondent	Number of sheep owned in 1995		Number consumed in 1995	Number sold in 1995	Average price per animal (KSH)	Income from sale of sheep (KSH)
	Mature	Young				
1 Mogotio	18	3	1	1	1,500	1,500
2 Mogotio	14	4	5	5	750	3,750
3 Suswa	100	61	10	50	1,250	62,500
4 Suswa	256	100	30	60	2,500	150,000
5 Suswa	40	16	18	3	1,800	5,400
6 Ngong	97	3	5	10	1,700	17,000

Table 3: Cattle inventory and transaction for the year 1995, all case studies.

Respondent	Number of cattle		Number consumed in 1995	Number sold in 1995	Average price per animal (KSH)	Income from sale of cattle (KSH)
	Mature	Young				
1 Mogotio	8	1	0	0	-	0
2 Mogotio	9	1	0	7	12500	87500
3 Suswa	120	20	0	10	7700	7700
4 Suswa	124	32	0	8	11500	92000
5 Suswa	50	6	0	0	-	0
6 Ngong	80	60	1	13	13000	169000

Table 4: Crop production and utilization, 1995, all case studies.

Respondent	Maize		Beans		Millet		Sorghum	
	Yield (bags)	Sold	Yield (bags)	Sold	Yield (bags)	Sold	Yield (bags)	Sold
1 Mogotio	0.00	-	0.00	-	0.00	-	-	-
2 Mogotio	4	0.00	0.4	0.00	3	0.00	3	0.00
3 Suswa	2	0.00	-	-	-	-	-	-
4 Suswa	8	0.00	3	1	-	-	-	-
5 Suswa	10	0.00	-	-	-	-	-	-
6 Ngong	-	-	-	-	-	-	-	-

Note that most of the available crop production is consumed. There was a crop failure in 1995. This reflects the high level of risk in the study areas. All but one farmer produced maize.

The first three show the importance of livestock production. Cattle, goats and sheep are major species, both for sales and consumption. These tables show that a substantial amount of income is derived from selling livestock. In the case of goats, off-take fluctuates between 6% and 50%. On the average, each household sells 23 goats per year and consumes 18. From the interviews, there was no indication that goat marketing was difficult. Farmers can sell their goats at competitive prices (Table 1). No respondent indicated there were input shortages, such as acaricide, antibiotics, and anti-helminths. Analysis of input purchases in all the respondents indicates that on average, they spend more money on anti-helminths followed by acaricide. Other important items are oxytetracycline and minerals.

Table 4 presents a summary of crop production and utilization in 1995.

Diseases of livestock.

Farmers were asked to rank livestock diseases in terms of importance. The purpose was to determine the relative importance of CCPP to other diseases that afflict individual herds. Table 5 presents the rankings of diseases.

From the ranking in Table 5, we see that CCPP is considered to be a very serious problem by all the respondents in this case study. According to the score which was computed using the ranking data provided by the respondents, CCPP is second to East Coast Fever, a tick borne disease that afflicts cattle. The presence of other diseases, especially those that afflict cattle, which are considered to present a greater challenge to the farmer and are of higher risk, may mean that the possibility of spending resources in CCPP control is high. If this proposition is true, they would spend more for controlling cattle diseases than for CCPP. Respondents were asked to indicate whether CCPP is a serious problem, is sometimes serious or is not a problem. All of them indicated that CCPP is a problem. However, this opinion contrasts with the rate of outbreak and mortality in their herds. Their participation in the experiment explains this perception, as well as the fact that in the study area there were farmers with CCPP problems while we were conducting the interviews. Table 6 presents information on herd morbidity and mortality with regard to CCPP for the period 1991-1996.

It shows that with the exception of two respondents, one in Ngong and one in Suswa, producers have had a CCPP outbreak in their herd at least once during the period under consideration. However, frequency of morbidity and mortality within individual herds is low. The last column of total mortalities from CCPP have been low, especially when compared to the herd sizes (see Tables 1 and 6). This would seem to be at odds with the assessment that CCPP is very serious problem. But CCPP is known for destroying entire herds of goats, causing losses to whole communities, especially when access to antibiotics is not timely. The respondents' assessment on CCPP as a serious animal health problem may be based on past experiences rather than on the present individual situation. Collectively, as mentioned before, the risk is present.

Table 5: Ranking of Diseases, 1996, all case study sites

	CCPP	TBD*	ORF	TRYPS	East Coast Fever	Enterotoxemia	Helminths	Foot and Mouth Disease
Farmer 1	1	2	4	3	0	0	0	0
Farmer 2	1	3	0	4	2	5	0	0
Farmer 3	0	2	0	0	1	0	0	0
Farmer 4	3	2	0	0	1	0	0	0
Farmer 5	2	0	0	0	1	0	3	0
Farmer 6	2	0	0	0	1	0	0	3

*Tick Borne Diseases

Table 6: CCPP Morbidity and Mortality Profile, All Case Studies 1991-1996.

Respondent	1996 MB	1996 MT	1995 MB	1995 MT	1994 MB	1994 MT	1993 MB	1993 MT	1992 MB	1992 MR	1991 MB	1991 MT	Deaths
1	1	1	1	0	1	0	1	0	1	0	1	0	2
2	0	0	1	1	0	0	0	0	0	0	0	0	5
3	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	1	1	0	0	0	0	5
5	0	0	0	0	0	0	1	1	0	0	0	0	A few kids
6	0	0	0	0	0	0	0	0	0	0	0	0	0

MB=morbidity MR=mortality 1=yes 0=no

Table 7: Vaccine Option, numbers and costs per herd in 1991-1996

Respondent	Number eligible for vaccination[1]	Vaccination charge (KSH/goat)[2]	Vaccination cost (KSH/year)	Total vaccination cost (1991-1996)
1	87	3	261	1,566
2	140	3	420	2,520
3	200	3	600	3,600
4	113	3	339	2,034
5	70	3	210	1,260
6	135	3	405	2,436

Table 8: Treatment Option with Antibiotics 1991-1996

Respondent	Number treated (1991-1996)	Treatment cost (KSH/goat)[3]	Treatment cost (1991-1996)	CCPP Mortality loses[4] (1991-1996)	Total cost with treatment (1991-1996)	
1	268	11	2,948	2,930	5,878	(1,566)
2	20	12.5	250	7,500	7,750	(2520)
3	0	14	0	0	0	(3600)
4	70	9	630	8,625	9,255	(2,034)
5	84	14.4	1,210	0	0	(1,260)
6	0	12.6	0	0	0	(2,436)

[1]This is the number of mature goats. The assumption is that young kids are not normally taken for vaccination. We have also assumed a constant herd size for the period 1991-1996.
[2]This is the current cost charged by the veterinary department for vaccinating one goat.
[3]Treatment cost is the estimated cost of treating a CCPP infected goat using oxytetracycline. The information that was required for this estimation was the price and quantity of the oxytetracycline purchased, and the dosage in ml that is required to complete a course of treatment.
[4]CCPP mortality losses are the losses incurred when a goat is killed by CCPP. For the individual respondents, this is computed by multiplying the number of goats killed by CCPP by the average price of a goat. Other output lost has not been included.

Cost-effectiveness of CCPP vaccination

Two alternatives exist to control Contagious Caprine Pleura Pneumonia: using oxytetracycline when there is infection; or vaccinating the herd to prevent infection. Both are efficacious forms of control, if the treatments are timely. According to Rurangirwa et al (1987), morbidity and mortality rates in a CCPP outbreak can, at times, be as a high as 100%. Therefore, the benefit of CCPP control measures, whether through vaccination or treatment, is the elimination of the economic loss that would otherwise be experienced because of CCPP related mortality. If the benefit sought in CCPP control measures is the elimination of CCPP related mortalities in goats, then the issue that we want to address is identifying control measures that are economically efficient.

In the present case studies, historical data on CCPP for each of the six respondents was collected for the period 1991-1996. There is information on CCPP outbreaks, mortality, and number of cases treated for CCPP. From this information, the cost associated with following the treatment alternative can be computed. It has two components, the first being the actual treatment cost, derived from the cost of the antibiotic used in treating CCPP, and the dosage administered to infected goats. The second component is the mortality losses which occur despite treatment (because of delays in treatment). Mortality losses can be expressed in monetary terms. Vaccination costs were computed by multiplying the number of mature goats owned by the household by the vaccination charge which is three KSH per goat. Tables 7 and 8 summarize the result of cost effectiveness comparison.

Results in Tables 7 and 8 show that the vaccination alternative would be more cost effective for the two respondents in Mogotio. It would also be cost effective for respondent 4 in Suswa. However, for the rest of the respondents, one in Ngong and two in Suswa, it would not be cost-effective to vaccinate, if we assume that the disease will behave in the same pattern, and that animals will survive with the treatment (we are not including lost outputs that cannot be consumed when treatment is carried out). There is a risk factor that has not been considered in this analysis. It is clear that treatment cost is a function of frequency of outbreak as well as mortality loss suffered in an outbreak. Therefore, when outbreaks are few and far apart, and when the consequent mortalities are minimal, treatment is a cost-effective alternative.

Case study findings

Six case studies were developed. Conclusions that are valid for the overall population cannot be derived from this study due to sample size and selection. But it is illustrative of the study that follows with the samples of Kitui and Koibatek that have been collected, cleaned and processed. From the cost-effective analysis, we conclude that the CCPP vaccine is cost effective in areas where there are frequent CCPP outbreaks, with high mortality rates. Therefore, farmers who believe this probability to be low may not be inclined to use the CCPP vaccine. This remains a hypothesis to be tested with the 137 farmers randomly selected. The existence of a substitute to CCPP vaccine, which farmers consider efficacious, will have an impact on the use and adoption of the vaccine. Oxytetracyclines are broad based antibiotics that are usually available. All the respondents in this case study possessed oxytetracycline and syringes, that they themselves administered to infected goats. When asked what is their current strategy for controlling CCPP, they all indicated that they use oxytetracycline. A contingent valuation question was asked to each respondent to assess their willingness to pay for the vaccine. All the respondents replied in the affirmative when asked whether they would be willing to pay ten KSH per goat per year for the CCPP vaccine. This question has been consistently asked in the large sample. It has already been noted that oxytetracycline is a substitute for the CCPP vaccine in the control of CCPP. Availability of substitutes will influence demand, as well as knowledge and trust that the vaccine is effective.

Factors Affecting the Demand for CCPP Vaccine: the Experience with Livestock Producers in Koibatek and Kitui Districts

Many different criteria have been used to define production systems, but all of them agree that climate (agro-climatic factors), type of livestock kept (livestock mix), and system of grazing are important criteria in defining a livestock production system. Since CCPP vaccine is a technology/input specific to the goats, it is expected that in production systems where the relative weight of goats is low, its use and adoption rate will also be low. Each of the selected production systems falls in an area occupied by people from different culture and ethnicity. Ethno-cultural characteristics may affect the rate of technology transfer. The survey includes production system and ethno-cultural characteristics to determine their relationship to use and adoption of the vaccine. The sites for the study are Koibatek and Kitui.

Approach for Koibatek and Kitui

Sample design and sampling procedures: a multistage sampling design was used. The districts to be covered were selected first. Four districts were originally selected purposively, one each from four different strata, to represent different production systems. As pointed out above, the four strata also coincided with different ethno-cultural backgrounds. Each selected study site represents a unique production system and ethno-culture. All districts important in goat production and endemic with CCPP were listed and stratified according to the criteria described above. On the basis of secondary information, we selected one district from each strata based on the extent of CCPP endemism and levels of CCPP vaccine deliveries in the recent years. The aim was to locate a study site where CCPP is endemic and the inhabitants have used CCPP vaccine or are aware of the existence such a vaccine.

A list of all divisions in the selected districts was compiled. One division was required for each of the selected district. To select the division, we enlisted the help of the local veterinary experts in each of the districts. The division to be selected had to meet the following conditions: a) must be a CCPP endemic area; b) the inhabitants should have used the vaccine or be aware of the existence of the vaccine; c) has a large population of goats. Other secondary considerations were accessibility of the area and security. Since a division is still a very large area, we further selected two administrative locations within the division. In stage three, two locations were selected, Koibos and Mugurin, using the same criteria for selecting the division. We compiled the sampling frame of households in the selected locations. To construct the sampling frame, we relied on local chiefs and sub-chiefs as these are the people who know the residents of the area under their jurisdiction. In stage four, 60 households were randomly selected from the sample frame. Following a similar procedure three locations were chosen in Kitui with the added criteria of identifying three distinct sites. In the case of Kitui we increased the sample size to 77 farmers. We originally intended to work with a larger sample that had been selected. The problems with the drought complicated data collection at the site.

Koibatek District

The first study site covered in the CCPP vaccine demand study was the Koibatek district. Koibatek district was carved out from Baringo district in July, 1995. Before Baringo was split, it had a goat population of 731,900 (GoK, 1995). It is estimated that the current goat population in Koibatek district is about 130,000 (Personal communication). Before the split, Baringo district was only second to Kajiado district in terms of goat population. This demonstrates that the Koibatek district is an important goat producing area in Kenya. Koibatek district is one of the arid and semi-arid districts in the country. However, within the district there are some high potential areas neighboring the hills and the highlands. Koibatek district receives two seasons of rainfall; the long rains from the end of March to the beginning of July and the short rains from the end of September to November (GoK, 1994). Rainfall varies from 1,000 to 1,500mm in the highlands to 600mm in the drier parts of the district. The majority of the population in the district is pastoralist, although there are a few small scale farmers. Goat production is an important economic activity in the district. According to GoK (1994). In 1992, there was a total of 3,616,350 livestock units in the whole of Baringo district, and out of this total, goats constituted 22.9%. Goats are the predominant livestock reared in the district and are kept by almost all households. Moreover, goat meat is very important in the district as 70% of the population depends on it as a source of protein.

Fieldwork procedures

A formal survey questionnaire was developed to capture the required data from the selected households. We had the opportunity to interact with Drs. Mukhebi and Swallow of the International Livestock Research Institute. Some studies in the area of contingent valuation provided information on the approach and content of the questions (Swallow et al, 1994 and 1995). The questionnaires developed for the formal survey were tested with six livestock producers in Suswa and Mogotio. After pretesting the questionnaire, and identifying collaborators at the site, the formal survey was applied. It took two months to interview sixty farmers. The selected households were contacted through area veterinary staffs. The area veterinary

Table 9: Houssehold Characteristics - Means and Standard Deviations KOIBATEK

Characteristic	Whole Sample	Koibos	Mugurin
Farm Size (Acres)	65.5 (67.0)	58.5 (78.8)	79.5 (29.8)
HH Size (Number)	6.9 (4.5)	5.6 (3.3	9.4 (5.6)
Adults Full-time Off-farm (Number)	0.4 (0.6)	0.3 (0.5)	0.5 (0.6)
Adults Part-time Off-farm (Number)	0.2 (0.5)	0.1 (0.3)	0.4 (0.8)
HH Head Schooling (Years)	3.4 (3.8)	4.1 (4.1)	2.1 (2.7)

Source: The CCPP Vaccine Demand Study Survey, 1996.
Note: The standard deviations are in parenthesis. Number of farm households in Koibos = 40; and in Mugurin = 20

officer and his two assistants were valuable because they understood the local language, assisted with translation of the questionnaire, knew the people, and understood the diseases.

Koibatek, Kitui, CCPP, and Information on Vaccines: A system description

The survey data was entered and cleaned. This was completed in March of 1997 for Koibatek and September for Kitui. Questionnaires were applied in Kitui, the second site from January through March, after developing the sample frame in December. The methodologies and questionnaires have been shared with KARI for their use at two other sites, Kajiado and Marsabit. We initially expected to collect data from 120 households in Kitui. As mentioned before, difficulties with the drought reduced our sample to 77 farmers. The sample size is now of 137 households.

Tables 9 and 14 present the social and demographic characteristics of the households at Koibatek and Kitui, respectively. Household size is larger in Kitui. Differences within a site are larger in Koibatek. Access to labor is large in Kitui, and it is also the site with hired labor. These may be related to the fact that the production system combines both crops and livestock. Household size and land size differences exist within each district, Mugurin holding the larger amount of land and family members. In the case of Kitui all families are large but Voo has the largest number of members. It also has the greatest number of

Table 10: Livestock Composition - Means and Standard Deviations KOIBATEK

Herd Composition	Whole Sample	Koibos	Mugurin
Local Cattle	13.8 (15.4)	12.2 (14.2)	17.1 917.4)
Grade Cattle	0.2 (0.9)	0.1 (0.2)	0.4 (1.6)
TOTAL Cattle	14.0 (15.8)	12.2 (14.3)	17.5 (18.3)
Local Goats	47.1 (41.8)	48.5 (46.3)	44.3 (31.9)
Grade Goats	0.2 (1.0)	0.2 (1.0)	0.4 (1.1)
TOTAL Goats	47.4 (41.7)	48.7 (46.2)	44.6 (31.6)
Local Sheep	10.4 (15.0)	9.5 (14.2)	12.0 (16.7)
Grade Sheep	0.1 (0.3)	0 (0)	0.2 (0.5)
TOTAL Sheep	10.4 (15.0)	9.5 (14.2)	12.0 (16.7)

Source: The CCPP Vaccine Demand Study Survey, 1996.
Note: The standard deviations are in parenthesis. Number of farm households in Koibos = 40; and in Mugurin = 20

members on farm, and greatest grazing area. Ikutha has the largest cultivated area. Koibatek has a larger herd of cattle and goats, as well as access to improved animals. Tables 11 and 16 show crop production consumption and sales. Koibatek has a low level of maize production compared to Kitui. Beans, cowpeas, millet and pigeon pea are planted in Kitui, with Koibatek plants fodder, maize, beans, sorghum and millet (Table 11). Some of the foods are for consumption, others for market. Yields differ within district. Tables 12, 13, 17, and 18 present what the farmers know about the disease, and what are the coping mechanisms. There is a large variation between and withing regions or districts. The number of years since the last epidemic are large in the case of Kitui, the agropastoral site, between 20 and 21years. The number of years was lower in Koibatek. Kitui is also closest to the market, 8 to 11.

Knowledge of the Vaccine

Tables 13 and 18 show that there are differences within groups regarding knowledge of the vaccine. At Koibatek the proportion of farmers who know about the vaccine is low (Table 17). There is a higher proportion of farmers who do not know about the vaccine (70%). Both Mugurin and Koibos have comparable lack of knowledge, between 75 and 67%. The distance to the nearest veterinarian (Table 12) is higher

Table 11: Crop Prodcution Consumption and Sales by Type - Means and Standard Deviations, KOIBATEK.

Crop	Whole Sample	Koibos	Mugurin
FODDER CROP (Acres)	0.4 (2.0)	0.2 (0.9)	0.9 (3.2)
MAIZE			
Acreage (Acres)	2.5 (3.0)	2.1 (1.5)	3.3 (4.7)
Quantity (Bags)	5.5 (24.6)	1.9 (4.0)	12.7 (42.0)
Consumption (Bags)	2.7 (5.6)	1.9 (4.0)	4.5 (7.8)
Sales (Bags)	2.7 (20.7)	0 (0)	8.2 (35.7)
BEANS			
Acreage (Acres)	1.6 (1.6)	1.6 (1.6)	1.4 (2.0
Quantity (Bags)	10.6 (24.0)	9.8 (22.8)	12.4 (26.7)
Consumption (Bags)	10.6 (24.0)	9.8 (22.8)	12.3 (26.8)
Sales (Bags)	0.03 (0.3)	0 (0)	0.1 (0.5)
MILLET			
Acreage (Acres)	0.4 (0.6)	0.3 (0.4)	0.5 (1.0)
Quantity (Bags)	13.0 (40.0)	12.4 (34.2)	14.3 (50.6)
Consumption (Bags)	11.5 (35.0)	10.1 (24.5)	14.3 (50.6)
Sales (Bags)	1.5 (11.6)	2.3 (14.2)	0 (0)
SORHGUM			
Acreage (Acres)	0.1 (0.3)	0.1 (0.2)	0.1 (0.5)
Quantity (Bags)	4.5 (23.9)	1.8 (7.1)	10.0 (40.3)
Consumption (Bags)	4.5 (23.9)	1.8 (7.1)	10.0 (40.3)
Sales (Bags)	0 (0)	0 (0)	0 (0)

Source: The CCPP Vaccine Demand Study Survey, 1996.
Note: The standard deviations are in parenthesis. Number of farm households in Koibos = 40; and in Mugurin = 20

Table 12: CCPP Vortality Morbidity in Numbers and Veterinary Services: Means and Standard Deviations KOIBATEK

Variable	Whole Sample	Koibos	Mugurin
Total Morbidity (1991-1996)	389.9 (2756.6)	572.4 (3375.3)	24.9 (31.4)
Total Mortality (1991-1996)	13.9 (27.3)	18.6 (32.0)	4.6 (8.9)
Years Since Last Epidemic	13.0 (5.3	12.2 (5.5)	14.5 (4.4)
Distance to Nearest Vet. (Km)	14.6 (16.3	18.3 (18.4)	7.3 (6.6)

Table 13: Knowledge about CCPP Vaccine and Willingness to pay 10 KSH per goat.

VARIABLE	WHOLE SAMPLE (NUMBERS)		KOIBOS (NUMBERS)		MUGURIN (NUMBERS)	
	YES	NO	YES	NO	YES	NO
Knowledge of CCPP Vaccine	14	46	10	30	4	16
Willingness to pay KSH 10/Goat	51	9	29	6	22	3

Table 14: Household Characteristics Kitui - Means and Standard Deviations KITUI

	WHOLE SAMPLE	VOO	MUTOMO	IKUTHA
Household Size (Number)	10.9 (6.1)	12.3 (7.1)	11.6 (7.1)	9.6 (3.9)
Adults Full-time On-farm (Number)	3.6 (2.2)	4.2 (2.1)	3.5 (2.5)	3.7 (2.0)
Adults Part-time On-farm (Number)	0.9 (1.2)	1.7 (2.1)	0.9 (1.0)	0.7 (0.8)
HH Members in School (Number)	1.4 (1.5)	1.2 (1.3)	1.5 (1.7)	1.3 (1.3)
HH Head Schooling (Years)	0.5 (0.7)	0.7 (0.9)	0.4 (0.6)	0.6 (0.7)
Perm. Hired Labor (Number)	2.8 (2.5)	3.9 (3.6)	2.7 (2.6)	2.5 (1.9)
Farm Size (Acres)	3.2 (3.9)	3.9 (4.7)	3.4 (3.6)	2.9 (4.0)
Cultivated Area Previous Year (Acres)	59.6 (71.5)	50.6 (27.0)	52.4 (58.3)	71.8 (93.5)
Grazing Area (Acres)	15.5 (13.0)	21.8 (23.1)	14.9 (11.3)	14.5 (10.8)

Table 15: Livestock Composition - Means and Standard Deviations KITUI

HERD COMPOSITION	WHOLE SAMPLE	VOO	MUTOMO	IKUTHA
Total Goats (Numbers)	19.0 (18.8)	17.1 (14.8)	12.4 (10.7)	28.3 (24.1)
Total Cattle (Numbers)	7.3 (7.5)	9.2 (10.4)	7.0 (7.2)	7.1 (7.0)
Total Sheep (Numbers)	0.9 (3.3)	1.1 (2.3)	0.1 (0.6)	1.7 (5.0)

for Koibos, more than double that of Mugurin. This is the village with higher mortality and morbidity related to CCPP (Table 12).

In Kitui, 45% of the farmers are aware of the existence of the vaccine; 86% are willing to pay for a vaccine that would cost ten Kenya Shillings, the estimated price of the freeze dried form. It is interesting to note that there are differences between the sites, with Ikutha having the highest proportion of farmers willing to pay for the vaccine, though mortality and morbidity were low in this area. The distance to market was high compared to Mutomo, the one with the highest awareness of the vaccine, but lower than Voo, with the higher mortality and distance to market (Table 17). They are also the largest producers of maize in the area, though the other sites grow more peas and beans. It is puzzling that they are, by comparison, the least willing to pay for the vaccine. Overall, Kitui is more aware of the existence of a vaccine than Koibatek (30%). Again the latter is interesting because several free vaccination campaigns were reported in this area (Lipner and Brown). The willingness to pay for the vaccine is equally important in both districts.

Table 16: Crop Prodcution Consumption and Sales by Type - Means and Standard Deviations, KITUI.

CROP	WHOLE SAMPLE	VOO	MUTOMO	IKUTHA
BEANS				
Yield (Kg)	23.6 (98.3)	0 (0)	25.4 (117.8)	28.6 (85.6)
Consumption (Kg)	13.0 (39.0)	0 (0)	13.6 (47.9)	16.2 (31.1)
Sales (Kg)	10.7 (65.7)	0 (0)	11.9 (73.0)	12.4 (66.9)
MAIZE				
Yield (Kg)	9.8 (11.5)	13.3 (13.4)	7.6 (8.9)	11.7 (13.5)
Consumption (Kg)	7.5 (7.3)	8.7 (8.2)	6.2 (7.0)	8.8 (7.5)
Sales (Kg)	2.3 (6.4)	4.7 (8.7)	1.4 (3.6)	2.9 (8.1)
COWPEAS				
Yield (Kg)	97.1 (170.3)	14.5 (19.0)	70.0 (66.7)	158.3 (254.3)
Consumption (Kg)	87.8 (168.3)	14.5 (19.0)	63.5 (63.9)	142.5 (254.4)
Sales (Kg)	9.3 (29.1)	0 (0)	6.5 (18.8)	15.9 (41.5)
MILLET				
Yield (Kg)	56.4 (119.1)	62.2 (118.0)	63.2 (120.8)	45.8 (120.6)
Consumption (Kg)	54.7 (119.1)	62.2 (118.0)	62.6 (120.6)	42.0 (120.5)
Sales (Kg)	1.7 (10.8)	0 (0)	0.5 (3.3)	3.8 (17.0)
PIGEON PEA				
Yield (Kg)	55.1 (236.1)	7.2 (15.6)	38.8 (84.0)	91.2 (370.8)
Consumption (Kg)	27.3 (64.1)	7.2 (15.6)	30.7 (53.7)	29.1 (83.4)
Sales (Kg)	27.8 (198.3)	0 (0)	8.2 (44.1)	62.1 (317.4)

Table 17: CCPP - Mortality, Morbidity and Treatment of Livestock Means and Standard Deviations.

VARIABLE	WHOLE SAMPLE	VOO	MUTOMO	IKUTHA
Total Morbidity (1991-1996)	9.5 (27.0)	37.8 (60.2)	8.2 (20.6)	2.3 (6.3)
Total Mortality (1991-1996)	4.0 (17.8)	19.7 (49.3)	2.5 (6.2)	1.1 (2.5)
No. Times Goat Vaccinated (1991-1996)	1.0 (1.3)	1.0 (1.2)	1.0 (1.6)	0.9 (1.0)
No. Times Cattle Vaccinated (1991-1996)	5.0 (1.9)	5.1 (1.8)	5.4 (1.6)	4.5 (2.3)
No. Years Since Last Epidemic (Base Year 1996)	19.9 (13.9)	18.4 (15.9)	19.4 (11.6)	21.1 (16.2)
Distance to Nearest Vet. (Km)	8.9 (6.4)	14.3 (12.1)	5.9 (3.3)	11.0 (5.0)
Distance to Nearest Vaccination Center (Km)	2.7 (1.6)	3.3 (2.0)	2.7 (1.8)	2.4 (1.2)

Table 18: Knowledge about CCPP Vaccine - Qualitative Variables KITUI.

VARIABLE	WHOLE SAMPLE		VOO		MUTOMO		IKUTHA	
	YES	NO	YES	NO	YES	NO	YES	NO
Knowledge of CCPP Vaccine	35	41	9	3	16	15	10	23
Willingness to Pay KSH 10/goat	66	10	4	5	34	4	28	1

Finally, data from these surveys showed that in Koibatek CCPP was ranked number one, by 40% of the sample. East Coast Fever was ranked second with 26 percent of the households in the overall ranking of diseases. Focusing only on goats, 69% of the households ranked CCPP as their number one problem. In Kitui 25% of the households listed CCPP as their number one problem in diseases, and 21% listed East Coast Fever.

Next steps

The data analysis from all the sites indicates that in both agropastoral and crop-livestock systems CCPP is perceived as a problem disease. In some areas both mortality and morbidity are high. Lack of awareness of the existence of the vaccine is an important fact, and the high willingness to pay for the insurance the vaccine provides seems to indicate that there is a potential demand for the vaccine. The study of Koibatek and Kitui included questions about problems with CCPP between 1991 and 1996. This information will be very useful in the multiple regression analysis that follows. We have collected information on the production systems to be able to analyze the influence of information, economic losses, other activities, education, and alternative measures to control the disease with their willingness to purchase the vaccine. Valdivia and Sheikh are taking the lead on this study at the University of Missouri.

Environmental

Research on animal health is targeted at improving the productivity and feed use efficiency of small ruminants.

Agricultural Sustainability

Loss of efficiency resulting from animal health problems is high, and prevention can reduce mortality and morbidity that result in economic losses. To contribute to sustainable livestock production systems, animal health is a necessary condition.

Contributions to U.S. Agriculture

Research experience in interdisciplinary research is crucial to sustainable production systems design in the U.S.

Contributions to Host Country

Animal health delivery systems are being transformed in Kenya, result of reforms and privatization. The present studies contribute to an understanding of how currently animal health services are delivered and the economic impact of diseases on the flocks of livestock producers in semi-arid and arid environments. Collaborative research with KARI scientists strengthens both U.S. and Kenyan research institutions. As seen in this study, lack of information and not lack of demand is apparently what constrains the use of vaccines. This study assists in understanding the mechanisms to improve marketing in rural areas.

Linkages

Linkages with Kenyan Veterinary Vaccine Production Institute and the Veterinary Field Services Offices have been established to provide information useful to institutions dealing directly with the producers. We also linked with ILRI to share methodological approaches.

Collaboration

The Sociology and Economics project bases its research in collaboration between Kenyan and U.S. scientists, and the component has a multidiciplianry approach. Collaboration with KEVEVAPI members and with veterinarians in the field have been part of our approach to research. We also collaborated with the Field Veterinary Services in Kenya.

Support for Free Markets and Broad Based Economic Growth:

Increasing net in kind and cash income, through efficiency in production, contributes to the welfare of families and enables them to accumulate and diversify to other economic activities, facilitating the development of demand, crucial in economic development. Marketing studies assist in understanding present constraints and opportunities for the delivery of products, such as the vaccine.

Contribution and Compliance with Mission Objectives

Private sector development is being emphasized by the USAID Kenya Mission. Our research is looking into privatization issues in animal health delivery services.

Concern for Individuals

The focus is on peasant household families, and the purpose is to increase their welfare. Some current practices of treating animals directly by the producers may have impact on family members if knowledge about the antibiotics is not known and products are consumed from treated animals. We are researching the knowledge of farmers regarding appropriate handling of antibiotics.

Support for Democracy

Improving the economic and nutritional well being of families through increase efficiency in production and reduced mortality of herds.

Comments

The drought of 1996/1997 affected our data collection efforts in Kitui. In both Kitui and Koibatek we thank the farmers for their participation and the field veterinary officers for the support. Research on this topic will continue at the University of Missouri and the Kenya Agricultural Research Institute. The activities listed under this component are part of the Sociology and Economics Project, which also included the research under the KDPG component.

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United States

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Sociological and Economic Analysis of Small Ruminant Production Systems: The Kenya Dual Purpose Goat

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Narrative Summary

This project has three main activities that include the Kenya Dual Purpose Goat Impact Assessment, animal health research focusing on the demand for Contagious Caprine Pleura Pneumonia (CCPP) vaccine, and the proposal developed to regionalize the Kenya Dual Purpose Goat Approach and Technologies. The first activity is reported under this component, the second under Animal Health through Biotechnology Component, and the third is very briefly summarized here, and reported full under "Negotiating Transitions: Small Ruminant Technologies for Zones Under Pressure". Social science researchers, as well as our colleagues from the other projects of this component, concentrated on two areas. The first, which demanded most of the group's effort, was the development of a proposal to regionalize the KDPG approach and technologies to Uganda and Tanzania. This was listed as problem statement number three in the sociology and economics project workplan for 1996-1997. The second area pertained to continuing analysis of the KDPG on-farm research, through the social and economic assessment of households and clusters at Machakos and the Coast, and included gender analysis. A plan was designed to insure that monitoring of the five pass-on clusters with Kenya Dual Purpose Goats continues in Kenya, and that research on the assessment of the KDPG component is completed. During the past year, monitoring of the clusters was absorbed by the Kenya Agricultural Research Institute (KARI), our host country collaborating institution for 18 years. Data analysis of the KDPG impact study will continue in 1998 with other funding sources. Graduate student research at the University of Missouri and KARI will be the avenue to achieve this. We report the highlights of the impact assessment at the household and individual levels below. Overall, we found that the KDPG enterprise was an important economic activity in the case of poor farmers, with limited or no access to credit. We also found that social networks play an important role in the success of the pass-on groups, overcoming poverty, and triggering adoption, as the Vuga cluster at the Coast has shown.

After 18 years of work in Kenya and the East African region, this is the last year of the Kenya SR-CRSP Components. Programs like this are not the result of the work of one or two individuals, but

to list all those who have contributed is impossible in a report like this. We would like to sincerely thank all our collaborating institutions, especially KARI, the farmers of Kenya for allowing us to intrude in their lives, our support staff for their commitment, our resident scientists for their dedication to the program, our collaborating scientists, and the many principal and co-principal investigators that worked tirelessly to make this research program an important resource for the region for the past eighteen years. In part, it is thanks to them that a new phase begins. *Nashukuru sana.*

Research

Activity I: Impact Assessment of the KDPG

During year 18, we developed alternative plans to fund this research activity. We identified four graduate and one undergraduate student through other sources, and they are conducting their research with the data collected by the social sciences project of the SR-CRSP. Three of our students are female research officers from KARI. This research contributes to institutional strengthening and improves the career opportunities of women in the sciences. The sociology and economics project is the only one with such a large team of female scientists working in collaboration with established KARI scientists.

Sustaining the Monitoring Activities

KARI provided funds to continue monitoring KDPG farmers, and capture relevant biological and socio-economic information for 1996-1997. Cluster monitoring of farmers testing the Kenya Dual Purpose Goat concentrated on three main activities. The first was to secure resources to continue data collection in 1996-1997. Data collected is comprised of the performance of the goats (breeding), the productions systems, health and the household's social and economic information of participating farmers in the KDPG test area (17 per cluster). The second was to design a simplified data collection instrument that captures information on the production, consumption, and exchange activities by all households in the sample, including those that have not yet received the KDPG. The Small Ruminant Research Coordinator for KARI, Dr. Wandera, is now responsible for overseeing the monitoring activity. The third included monitoring assistance by the socioeconomics group at KARI for the Machakos sites, and hiring of a field assistance for the Coast clusters to secure information on the last two seasons (1996-1997) with the new simplified instruments.

Dr. Mbabu as our co-principal investigator, and Dr. Lutta, former resident scientist and main host country collaborator who took the lead in developing a new instrument with Valdivia, and assisted in coordination of the monitoring at Katumani and the Coast. KARI scientists from Katumani are now responsible for monitoring the Machakos clusters, with assistance from Mr. Asambu, socioeconomics KARI. Given a different personnel situation at the Coast, we funded an assistant to apply the new instruments in Kwale and Kilifi.

Data Base Construction

To prepare for analysis of the longitudinal data, Dr. Lutta spent some time with our program, and was involved in processing the monitoring data captured in 1994, 1995, and 1996 into condensed files with households as the unit of entry. This was meant to integrate the monthly questionnaires for 87 farmers, the Agricultural, Inputs and Outputs, for every season. A code book for each data base was developed, and data file instructions were also developed for the production systems, breeding, and health information. This data is being analyzed by KARI-MU social scientists, and is a source of data for three thesis projects at the University of Missouri.
This data base is also being used by KARI social scientists. A final report of the KDPG impacts in semi-arid and sub-humid environments of Kenya is being developed with Dr. Lutta. A report integrating all the Kenya projects is being prepared under the lead of Dr. Wandera.

Graduate Research Activities

The longitudinal (1994-1997) monitoring data, the baseline data of 1993-1994, and the 1996 labor, resources, and management data base, are analyzed through thesis research. Three projects are on going to date. These are:

Development of methods to assess the impacts of livestock technologies on household welfare. A dissertation research project was developed and submitted for funding to the Rockefeller Foundation. Using the monitoring data and a one time ex-post assessment instrument on food security strategies, the research will develop methods to measure the impacts of livestock technologies on household welfare. This study departs from traditional impact studies that measure outputs or inputs. The design of the research clusters will allow Sheikh to treat the observations in a quasi-experimental design. The study is longitudinal; it will compare the conditions encountered in 1993-1994 to those in 1998. The research activity on impact measures is described in the "Negotiating Transitions: Small Ruminant Technologies for Zones Under Pressure" section of this report. Both KARI and ILRI scientists will be co-advising in this research. The initial data set consisted of 100 farmers. Data processed and coded this year will be used to compare with the baseline 1994, the monitoring of 1995 and 1996, and ex-post observations of 1998. This research is not being supported by the SR-CRSP, but is based on the data generated by this project.

Studies of social capital.
Kenya: A Masters student in agricultural economics at the University of Missouri, Ms. Kyoko Koga is working with the KDPG data base to develop indicators of social capital at the household and cluster (farmer pass-on groups) level, which will be correlated with success of the pass-on of the KDPG, and numbers of KDPGs at the household level. She will complete her research in August of 1998, and is not supported by the SR-CRSP. The indicators used to measure social capital are membership in groups, type of community, diversity of economic activities, access to credit sources, and indicators of cluster

cohesiveness derived from de Haan et al. 1996.

Tanzania: In the area of social capital, a proposed approach and methodologies, and a review of the literature was presented in the proposal for the SR/GL-CRSP. With other funding sources in collaboration with Heifer Project International, we have a doctoral candidate, Ms. Nicoline de Haan, under the advise of Dr. Jere Gilles and Valdivia, conducting field research on social capital in Tanzania. Her research is reported in the "Negotiating Transitions: Small Ruminant Technologies for Zones Under Pressure" section of this report. She is currently working in northern Arusha with support from the Brown Fellowship, University of Missouri. Ms de Haan was a graduate research assistant with our SR-CRSP Project. Her research focuses on the interface between research and development, and identifies the role of social capital in adoption of livestock technologies. In this case, we focus on social capital as a catalyst in the process to access and inform on technological innovations. Our assessment of livestock development projects in both Tanzania and Uganda, as it relates to performance of introduced breeds, indicated that it has not been very successful in terms of productivity when compared to the breed's potential. The research proposed would have explored approaches to achieve performance, in collaboration with non governmental organizations. These organizations seldom conduct research, which is why they are interested in partnering with research organizations.

Returns to research investments in the Small Ruminant SR-CRSP. The case of the KDPG. The data collected and processed will be used by Ms. Nancy Nganga, a KARI social scientist working on her Masters degree in agricultural economics (funded by the World Bank), to measure the returns of research investments in Kenya by the SR-CRSP/ KARI/US Universities collaboration of 18 years. The data gathered captures changes in income at the household level as a result of the introduction of the KDPG. This is compared to similar households that have not yet incorporated the KDPG to measure the change in net income. Based on the designed multiplication schemes, projections of KDPGs and improved goats will be estimated and used to calculate the social rates of return with an economic surplus model. The simulation will be based on numbers projected by the breeding project based on the commercial multiplier and pass-on/upgrading multiplication schemes. The methodology will be similar to the Returns to Inyestment research in Indonesia (Valdivia, 1993). The existence of longitudinal data of the KDPG, both at the cluster and household level, and the data base processed by Dr. Lutta facilitate this research.

Women in Agriculture, a case study of the KDPG. This was an undergraduate internship (University of Missouri) that allowed Ms. Grace Njeru (KARI field officer) to work with the questionnaires applied in 1996 to gather information on gender of the KDPG technologies, land resources and management, and access to information. She processed the questionnaires, developed a codebook, and conducted preliminary analysis of the data. A technical report on her internship experience, and relevant data on gender, credit, and management of activities at the household level were reported. This preliminary assessment will be integrated to the impact assessment study of the KDPG.

The above activities of the impact assessment of the KDPG are on-going, and contribute to institution building through research and training of KARI and other scientists. We view the research conducted on social capital and welfare impact indicators as essential to development, and to establishing a continuum between research and development.

Research Progress of the Kenya Dual Purpose Goat Impact Assessment

Background: The Kenya Dual Purpose Goat (KDPG) was developed by the SR-CRSP, contributing to family welfare in areas of high population density, increased fragmentation of land property, and difficult access to markets. Early crosses of this breed (F1s) were introduced in Western Kenya where the component developed a feeding support and a management and production technological package (Hutchcroft and Semenye). The four way cross had not been tested on farm. It was therefore necessary to determine if the KDPG, now fully developed, and supporting technologies would be flexible enough to adapt to other agroecological and socioeconomic environments.

Some previous findings indicated the interest in forage techniques in areas of decreasing land size. On the other hand, in relatively less densely populated areas, there was interest in the animals and extensive grazing (Sheikh; Nyaribo and Ospina). As SR-CRSP funding decreased and became uncertain, the need to integrate this research activity to KARI programs increased. Two research centers were selected for collaboration. These were located in areas of similar social, demographic, and/or environmental characteristics of Western Kenya. This collaboration started in 1994, the year of budget cuts to the SR-CRSP. Collaborating scientists at Mtwapa Regional Research Center and Katumani National Dryland Farming Research Centre assisted in the development of a research plan to test the KDPG on farms. Two districts were selected at the Coast, with high rainfall and population density, Kilifi in the north and Kwale (Vuga and Matuga/HPI clusters) in the south. The dry-land extensive farming system assessment was conducted at two sites in Machakos: Kitanga's hill masses of recent settlement, and Kimutwa's lower plains with lower population density.

The original sample consisted of five clusters, each containing 20 farmers selected at random from a developed sample frame. The Matuga cluster was the only one purposely selected. From each group of 20 farmers, five were randomly selected to receive two pregnant KDPG does each, the remaining fifteen farmers would be "in waiting". Our research control group would oversee that farmers manage the goats with care. The Heifer Project International "pass-on" approach for dairy cattle in the Kwale district was used and distribution started at the end of 1993 in Machakos and Kwale. Farmers in Kilifi received their does in March of 1994, and unlike the previous ones, these were not pregnant, retarding the "pass-on" for at least six months.

The households in these clusters are defined as peasant household producers, facing consumption and production decisions that are interlinked. Risk and food insecurity affect the decision making process. The clusters and households experience varying degrees of market integration as some products are mostly consumed while others are sold. Labor sales may be occasional or permanent, in order to diversify and obtain wage income (Fafchamps, Low, Annual Report 1995). An objective of the KDPG technology is to increase milk availability at the household level. Other benefits include: increased possibilities of storing wealth through small ruminants and sales of bucklings as breeding stock. These are used by farmers to upgrade their local East African goats, which are well adapted to the region and small in size.

Three levels of socioeconomic analysis of the KDPG were conducted: the household production system, the market, and the community. The first focuses on the impact of the new goat enterprise on the household and on individual members, measuring the economic viability and the changes in household resource and income allocation. The second level was a market study, conducted last year. It focused on the commercial multiplication of the KDPG and market price study of breeding stock. In collaboration with KARI, a system for commercial multiplication of the breed was also established. The third level, the community, analyzed the impact of the pass-on mechanisms to determine the positive and negative externalties resulting from the formation of the groups (de Haan et al. 1996). The study of social capital conducted by Ms. Koga falls into this category.

Impact Analysis at the Household

There is special interest to determine the impact on the welfare of households, both by the direct introduction of the KDPG as an economic enterprise, and by building assets that are important to smooth income shocks (Reardon, et al, Morduch, Townsend), the result of idiosyncratic risk. The effects of the KDPG on-farm is measured by its outputs, changes in intrahousehold allocation of resources, and use of income that changes the bargaining position of members of the household. Asset accumulation contributes to economic security, especially food security. Expenditure patterns of men and women differ, especially in Kenya (Quisumbing et al., Haddad et al.). If KDPGs are identified as belonging to the income domain of the female head of household there are higher probabilities that milk and cash from this activity will be spent on consumption items for the family. The position of women within a household also effects income distribution (Conelly and Chaiken, 1993).

Assessment of the impact of the KDPG focused on: (1) income generation, cash and in-kind of the KDPG enterprise, and the diversity of economic activities carried out by the household producers on and off the farm; (2) intrahousehold allocation of resources focusing on labor and income, to determine domains of the economic enterprises; and (3) the flexibility of this technological package as it integrates into the household economy. We hypothesized that products of the KDPGs provide increased household consumption if management and income are controlled by the member responsible for the household's reproductive activities (i.e., food preparation and child care).

During year 18, monitoring activities of the Kenya Dual Purpose Goat relied mostly on KARI scientists. The instruments prepared by social sciences this year consisted of two instead of the traditional four applied several times during the year. Social sciences remained responsible for the collection of the data at the Coast. A questionnaire was synthesized by Dr. Lutta, and has been shared with HPI for the purpose of impact assessment. The task of constructing variables at the household level was also the responsibility of Dr. Lutta, as he prepared the original monitoring data files. Similar work was done at the University of Missouri by Nancy Nganga to construct aggregate information per household. The baseline information and the monitoring data will be used by Dekha Sheikh in her doctoral dissertation research to develop impact indicators of the welfare of the KDPG at the household level. The management, labor and resources questionnaire, applied until November of 1996 was processed at the University of Missouri with the assistance of Njeru. The households were monitored until August of 1997 at the Coast. Further support from KARI is uncertain for this activity. Sheikh will conduct an ex-post survey in 1998 to identify the role of the KDPG in consumption smoothing and asset accumulation at the household and individual levels. Regression analysis of the data will be performed this year through several research projects. Household performance will be correlated with access to credit, number of membership in women groups, and other networks as indicators of social capital influencing accumulation at the household level.

The setting of the KDPG impact assessment research on farms.

Machakos: The Machakos district is in Eastern Province, Kenya, and the main ethnic group is the Akamba. Rainfall variability characterizes this region with averages fluctuating between 500 and 1300 mm/yr. This region has two cropping seasons defined by the rainfall pattern; March through July, the long rains; and the end of October through December (Jaetzold, 1983) the short rains. Temperatures vary from 10 to 26 degrees Celsius, and droughts are a common occurrence in this semi-arid region.

The study area comprises two production systems, the hill masses of recent settlement (Kitanga) and the low plains (Kimutwa) with higher population density. Family size, years of schooling for the families in each cluster, and average number of months spent on the farm by family members are described in Table 1. Household size fluctuates between 7 and 8 members, with several working on the farm part time. The average level of education is 6 years. Land size, storage facilities, and number of oxen used in farming are presented in Table 2. There are differences in land size between the clusters.

Table 1: Demographic Characteristics of Machakos and the Coast in Averages, 1993-1994

Region	Cluster	Family size	Years of schooling	Time spent on farm
The Coast	Kilifi	9.1(0.8) 20	5.3(0.2) 87	7.7(0.4) 163
	Vuga	8.9(0.6) 21	5.7(0.3) 121	6.7(0.4) 164
	Matuga	6.2(0.6) 18	7.7(0.3) 78	6.9(0.4) 86
Machakos	Kitanga	8.2(0.4) 20	5.5(0.2) 125	6.5(0.3) 134
	Kimutwa	7.4(0.5) 20	6.4(0.3) 120	6.3(0.3) 119

Source: Baseline questionnaire Social Sciences SR- CRSP- Machakos and Coast, Kenya. Number on top = mean, (std deviation) Number at bottom = sample size

Crop farming includes fast growing varieties of maize such as the Katumani, beans and pigeon peas, cassava, sorghum, green grams and millet. Cassava, fruits (mangoes, guava, pawpaw, etc.) are sold when yields are high.

Most Machakos farmers keep local and grade cattle, sheep and the Small East African goats (Table 3). These animals are easy to manage, hardy, and well suited to the harsh environment. The introduction of a new technology package that includes feeding techniques, housing for the goats, milking, de-worming, kidding, record keeping, and ensuring proper care are new to the community, since local animals require little attention. Goats in this region have been the woman's domain in terms of management such as tethering, watering and milking. New animals requiring different care pose new labor demands on women. Table 4 shows milking of cattle and goats in each cluster.

<u>The Coast (Kwale and Kilifi):</u> Two districts were chosen for this study at the Coast. They represent unique ethnic groups, agroecological zones, and climate patters. Kilifi in the north, is mostly a Christian community, and Kwale in the south, is Muslim. the Coast's ethnic groups belong to the Mijikenda with a small percentage of immigrants such as the Kikuyu, Akamba, and Taita who have bought land and settled there. The climate differs between the north and the south, and Kilifi's rainfall is unreliable. Kilifi, in the plains, has a temperature range of 26 to 30 degrees Celsius. Kwale, in hilly territory, is warmer with temperatures ranging between 30 and 34 degrees Celsius. Farmers crop and raise livestock. Land is highly fragmented (see Tables 1, 2 and 3). The most dominant crops are coconuts, cassava, cashew nuts and millet. These are zone specific as a result of differences among the north and south soil types and climate. Kilifi is a coconut, cassava and cashew nut zone while Kwale is mainly a coconut zone.

Findings ex-ante of the household production system

The baseline data shows special differences between clusters in the Coast, particularly with Matuga, a group exposed to more years of schooling and a smaller family size. In terms of assets this cluster had less storage facilities, and small land size. The Coast does not use oxen for cultivation and has a smaller land area than Machakos (Table 2). All households possess poultry (Table 3), all manage local goats, and Kilifi and

Table 2: Average Assets in Land, Granaries, and Oxen in Machakos and the Coast, 1993-1994

Region	Cluster	Land(acres)			Granary(#)	Oxen (#)
		Quantity (acres)	Parcel			
			number	area(acres)		
The Coast	Kilifi	21.7(3.7) 20	2.3(0.3) 20	9.78(0.7) 46	1.4 (0.2) 20	0
	Vuga	15.7(2.3) 19	2.6(0.3) 21	5.8(0.9) 52	1.7(0.1) 18	0
	Matuga	9.3(1.6) 17	2.1(0.2) 18	4.0(0.8) 39	0.7(0.2) 18	0
Machakos	Kitanga	27.9(7.4) 20	1.4(0.2) 20	19.9(5.6) 28	1.2(0.2) 20	1.1(0.3) 20
	Kimutwa	17.1(3.6)20	1.6(0.2) 20	11.5(2.3) 29	1.1(0.1) 21	1.5(0.3) 20

Source: Baseline questionnaire Social Sciences SR- CRSP- Machakos and Coast, Kenya.
Number on top = mean, (std deviation)
Number at bottom = sample size

Table 3: Livestock in numbers at Machakos and the Coast, 1993-1994.

Region	Cluster	Cattle		Local Goat	Sheep	Chicken
		Grade	Local			
The Coast	Kilifi	2 2	4(1.5) 12	8(1.3) 12	0	30.3(6.4) 15
	Vuga	4 1	0	5.4(0.9) 14	0	10.8(4.0) 16
	Matuga	2.1(0.5) 11	4.5(1.5) 4	9.8(1.0) 18	6 1	21.4(6.5) 13
Machakos	Kitanga	4(1.3) 6	4.1(0.6) 13	5.8(1.0) 18	2.5(1.5) 2	10.2(1.6) 17
	Kimutwa	0	5.9(0.9) 19	5.1(0.6) 18	1.7(0.3) 6	14.2(3.3) 18

Source: Baseline Questionnaire Social Sciences SR- CRSP- Machakos and Coast, Kenya.
Number on top= mean, (std deviation) Number at bottom = sample size

Table 4: Cow milk production, consumption and sales on a daily basis at the Coast and Machakos, 1993-1994 (liters)

Region	Cluster	Produced	Sold	Consumed
The Coast	Kilifi	3(0.3) 5	4 1	2.4(0.4) 5
	Vuga*	8 1 (4 G)	6.6 1	1.5 1
	Matuga*	5.82(1.1) 11 (2G)	5.7(0.9) 9	1.4(0.2) 10
Machakos	Kitanga	4.8(0.8) 12	3.4(0.9) 7	2.7(0.3) 11
	Kimutwa*	5.1(0.4) 9 (2G)	2.5(0.5) 2	4.6(0.2) 9

Source: Baseline questionnaire Social Sciences SR- CRSP- Machakos and Coast, Kenya.
Number on top= mean, (std deviation) Number at bottom = sample size
* Also harvested goat milk =#G

Machakos had comparable numbers of local cattle. Grade cattle was common in Matuga (the HPI group) and Kitanga. Few families consume milk at the Coast, while 50% of those in Machakos do. Only eight farmers harvested goat milk, six at the Coast and two in Kimutwa.

Gender Analysis

As mentioned in last year's report in 1996, a survey was applied to the cluster farmers in order to capture information on the management and labor allocation of the KDPG by gender, land titles, access to and information on credit, selling and buying food and agricultural inputs, and decisions related to the technological package.

Interviews were conducted in both regions. Tables 5 through 7 report on 35 households in Machakos and 23 at the Coast. All the farmers participating in the project at the Coast were interviewed; reported are only those with KDPGs. More extensive statistics are reported in Njeru, 1997. Gender of the head of household (see Table 5), at both sites was male. Only in the case of widows, was the the woman reported as head of the household.

Since the start of the KDPG component we have distinguished between head of household and farm manager. Studies in Western Kenya found this distinction to be important, as a result of males migrating to urban areas in search of off-farm employment and income. As a result, many decisions along with labor allocation, are the responsibility of the female head of household. As Table 5 indicates, this trend is especially important in Machakos, where men migrate and often have full time employment away from the homestead. The situation differs at the Coast (Table 6), where 60% of the farm managers were male heads of household. Still, an important proportion of women are considered farm managers in this region. The proportion of male managers differ at the Coast between the north and the south. Sixty percent of the managers were men in Kwale and 70% in Kilifi. Kwale is closest to urban centers, providing higher opportunities for off-farm employment, as shown in Table 1.

Table 5: Gender of Household Head at the Coast and Machakos in 1996.

	Machakos		Coast	
Household Head	Frequency	Percent of total	Frequency	Percent of total
Male (M)	33	94.3	22	96
Female (F)	2	5.7	1	4
Total	35	100	23	100

Source: KDPG Labor, Resources and Management Survey 1996

Table 6: Gender of Farm Manager at Machakos and the Coast, 1996.

	Machakos		Coast	
Farm Manager	Frequency	Percent of Total	Frequency	Percent of Total
Male (M)	5	14.3	14	61
Female (F)	30	85.7	9	39
Total	35	100	23	100

Source: KDPG Labor, Resources and Management Survey 1996

Individual property characterizes both the Coast and Machakos. Some sites have been recently settled, Kilifi in the Coast and Kitanga (the hills) in Machakos. Existing land titles are in the name of the male head of household. The only cases in which the title of the land belongs to the female is in the case of widows. Table 7 shows that the proportion of titled land is higher at the Coast. Untitled land is still high, especially in Machakos. The fact that the titles are in the hands of the male head of household is a problem when women seek traditional credit sources (Njeru, 1997; Sheikh in 1992 for Western Kenya).

	Machakos		Coast	
Title Holder	Frequency	Percent of Total	Frequency	Percent of Total
Male (M)	8	23	10	44
Female (F)	2	6	1	4
No Title	25	71	12	52
Total	35	100	23	100

Source: KDPG Labor, Resources and Management Survey 1996

Table 7: Land Property by Gender of Title Holders.

Off-farm employment

Often, a common strategy for increasing household income is through off-farm employment. The literature on peasant household production systems cites this as a risk reducing strategy and a means to maximize labor use. As a result, women became farm managers of both food and cash crops (Chaiken and Conelly, 1993). Male heads of household may work away temporarily or permanently, sending home remittances (Table 8) as reported for Machakos. This region, with 35 households, shows 53 members working off-farm, 48 males and only 5 females (Table 8). Twelve households at the Coast have members working off-farm, 18 males and 2 couples. Women mostly work on farm and household activities. Permanent employment off the farm was sought by 28% of the residents of Machakos and 13% at the Coast. Part-time and wage labor jobs were 72% in Machakos and 87% at the Coast. In both regions, 85% of all off-farm income was spent in household consumption.

Labor allocation

The KDPG package includes several tasks that are not part of traditional husbandry practices. Tables 9 and 10 list

Region	Cluster	Most cited income source	Most cited frequencies for receiving off farm income -Income range/mean
The Coast	Kilifi	24 (8) 28(5) 16 (4)	1(15) -1489 20(9) -102
	Vuga	12(5) 6(4)	1(24) - 875 2(3) - 8400
	Matuga	19(8) 16(4)	1(10) -1594 20(4) - 79
Machakos	Kitanga	32(16) 7(9) 16(5)	1(11) -1073 2(11) -2189 4(10) - 60
	Kimutwa	32(9) 7(8) 16(5)	1(17) - 1426 4(8) - 112 2(4) -1833

Source: Baseline questionnaire Social Sciences SR- CRSP- Machakos and Coast, Kenya. First number = most cited source

Key

Source:
- 6 = wife(business)
- 7 = remittance from sons
- 12 = remittances
- 16 = HH employment
- 19 = business
- 24 = wine tapping
- 28 = agric casual labor
- 32 = women group

Frequency:
- 1 = monthly
- 2 = yearly
- 4 = anytime/ when possible
- 20 = daily

Table 8: Sources of Off farm income (frequencies) Reported in 1993-1994.

Table 9: Machakos, Summary of Gender Division of Labor and Decision Making (12 KDPG farmers) in 1996. (Frequencies)

	Labor Allocation				Decision Maker			
Activity	Male	Female	Both	No data	Male	Female	Both	No data
Milking	1	6	1	4	1	5	2	4
Fetching water	2	5	1	4	1	4	3	4
Fodder Planting	1	5	5	1	4	2	3	3
Record Keeping	4	3	0	5	1	3	1	7
Cut & Carry	1	7	3	1	1	6	4	1
Herding	5	1	2	4	1	3	4	4
Spraying & Dipping	11	1	0	0	5	1	3	3
Tethering	1	5	2	4	0	4	4	4
Kidding	3	4	3	2	1	1	1	9

Source: KDPG Labor, Resources and Management Survey 1996

these for the Coast and Machakos, indicating if the task is accomplished by the male or female head of household, and who makes the decision. In Table 7, Machakos, 11 of the 12 farmers planted fodder; women were as responsible as men for this activity. More women also decided on milking, water fetching, record keeping, and cut and carry activities. Men did most of the record keeping, herding, spraying and dipping. Low levels of literacy rate in women explain why men are responsible for record keeping. The baseline study found that men have more years of education than women. This affects spraying and dipping activities which require reading labels and directions. Herding requires more time which is mostly conducted by men, while tethering, usually closer to home, is done by women. Milking and fetching water are household reproductive activities. Although simulation model (see Productions Systems Report) indicates that labor is not a constraint, the gendered nature of these activities does place a special demand on women, especially when coupled with migration and seasonal off-farm employment.

At the Coast, (Table 10) tethering and kidding were distinctly women activities. One should note that a study of activities in Western Kenya (Conelly and Chaiken) showed wealth as a condition that overpowers gender in decision making. This means that as wealth changes, the roles defined by gender may be defined by wealth (or lack thereof). All other activities were reported as carried out by men rather than women. This (at least in the realm of decision making) is due to the fact that a higher proportion of men stay home in the Coast.

Table 10: The Coast, Summary of Gender Based Division of Labor (22 KDPG farmers).

	Frequencies				Decision Maker			
Activity	Male	Female	Both	No data	Male	Female	Both	No data
Milking	5	2	0	15	4	3	0	15
Fetching water	11	10	0	1	11	10	0	1
Planting & caring for fodder	4	3	6	9	10	12	0	9
Record Keeping	10	1	0	11	9	1	0	12
Cut & Carry	7	1	2	12	7	3	0	12
Herding	9	4	6	3	14	5	0	0
Spraying & Dipping	14	3	3	2	17	5	0	0
Tethering	2	9	8	3	9	8	2	3
Kidding	7	11	3	1	8	8	1	5

Source: KDPG Labor, Resources and Management Survey 1996

Livestock sales

Livestock sale decisions differed between regions. Ten of the 18 farmers in Machakos selling livestock (goats, cattle, sheep and chicken) were women. Of these, six sold goats, three sold chickens, and one sold goats and chickens. Six of the ten sold their animals at home, the rest at the local market. The revenue was spent on household consumption goods. Four men sold livestock; four sold small ruminants, one also sold cattle. Some selling was decided by couples. Twelve households sold livestock at the Coast, and most of these were conducted by men. Half of the sales took place at home. It is interesting to note that in all cases at the Coast and Machakos, the source of money for food and input purchases is the man, wealth is perceived to be his (Tables 11 and 12).

Crop Sales

Most farmers in Machakos grow food crops such as maize (corn), beans, sorghum, pigeon pea, and vegetables. Some of them grow forage crops, and use crop residue for forage. The decision to sell crops is usually joint, but the actual selling is done by the woman. Crop sales provided 60% of the income used in welfare purchases, and agricultural inputs and supplies such as seeds, fertilizer and livestock. At the Coast, farmers concentrate on tree crops such as cashewnuts and coconuts. Seventeen of the 23 households sold crops, mostly conducted by men, and all the income was spent on household consumption, including school fees.

Buying Food and Inputs

Food and input purchases by gender are presented in Tables 11 and 12 for Machakos and the Coast. Ninety-four percent of the farmers in Machakos purchased farm inputs (i.e., fertilizer, seeds, tools, etc.). Sixty percent of these were made by males, and 33% by females. Decisions on purchased inputs were evenly distributed among males (13), females (11) and couples (11). All of the 35 farmers interviewed said that they bought food to supplement what they grew on their own farms. Of these, 74% were female; 97% of the decisions regarding food purchases belong to women.

Males provided over 90% of all income to purchase food and inputs at the Coast, and did most of the purchasing. Unlike

Table 11: Decisions, Sources, and Food and Input Purchases, by Gender at Machakos in 1996.

		Gender of buyer			Decision Maker			Source of Money		
Activity	# of HH buying	M	F	B	M	F	B	M	F	B
Inputs	33	20	11	2	13	11	11	31	1	3
Food	35	4	26	5	1	34	0.00	33	1	1

Source: KDPG Labor, Resources and Management Survey 1996
Note: HH=household; M=male; F= female; B=both (male and female).

Table 12: Decisions, Sources and Food and Input Purchases by Gender at The Coast in 1996.

		Gender of buyer			Decision Maker			Source of Money		
Activity	# of HH buying	M	F	B	M	F	B	M	F	B
Inputs	19	14	3	2	14	3	2	18	1	0.00
Food	23	11	4	8	3	10	10	21	1	1

Source: KDPG Labor, Resources and Management Survey 1996
Note: HH=household; M=male; F= female; B=both (male and female).

Machakos, where women purchased most of the food, men at the Coast did most of the food purchases, although women were still in charge of food decisions. These results corroborate cited findings regarding the relevance of women in food and household nutrition decision making.

Access and information on credit

Limited resource farmers frequently have limited access to commercial sources of credit. This is important both for productive and household reproductive activities. It is also important to smooth consumption shocks (lack of food) during bad seasons. Many types of credit sources exist. Well functioning rural financial institutions are believed to be essential to improve economic efficiency, reduce income risk, and improve income in the rural communities. Credit is important to the introduction of some technology elements of the KDPG. Input purchases such as de-wormers and dipping require cash. Understanding what types of credit facilities these farmers have, or are aware of, in their community enables us to propose recommendations that facilitate adoption of the KDPG package. Machakos and the Coast had money markets consisting of both formal and informal lending institutions. Local commercial banks, parastatals such as the African Farmers Co-operative Society and commodity corporation (Kenya Tea Development Authority (KTDA)), non-governmental organizations and other co-operative societies/unions are present in rural areas. Informal credit sources consist of landlords, friends and relatives, rural merchants, women and church groups. According to our survey results, little interaction exists between farmers and the formal lending institutions. Most farmers received credit from informal lenders, that require little or no collateral, both for consumption and production investments in small amounts of money.

Figure 1: Volume of Credit by Source - Machakos Clusters.

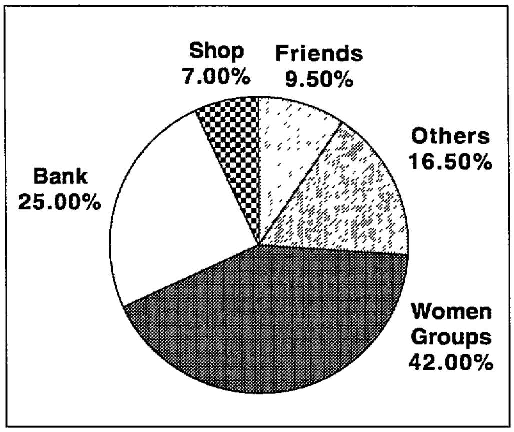
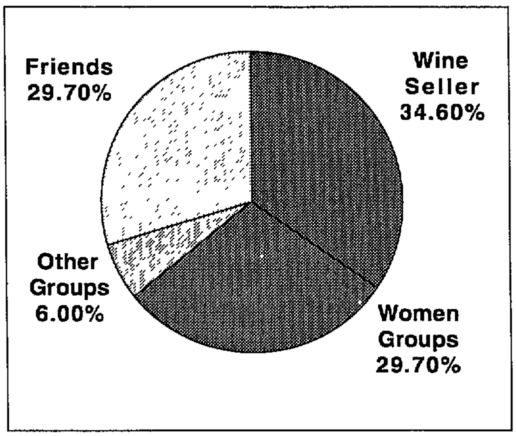


Figure 2: Volume of Credit by Source - Coast.



Twenty-five percent of the farmers in Machakos were aware of the existence of commercial banks, but did not know about parastatals, commodity cooperatives or non-governmental organizations. Eighty-three percent were aware of co-operative societies, eighty-nine percent of friends, neighbors and relatives as their credit source, and eighty percent of rural merchants. Informal sources of credit are better known than most of the formal ones. *Figures 1* and *2* show the volume of credit by source

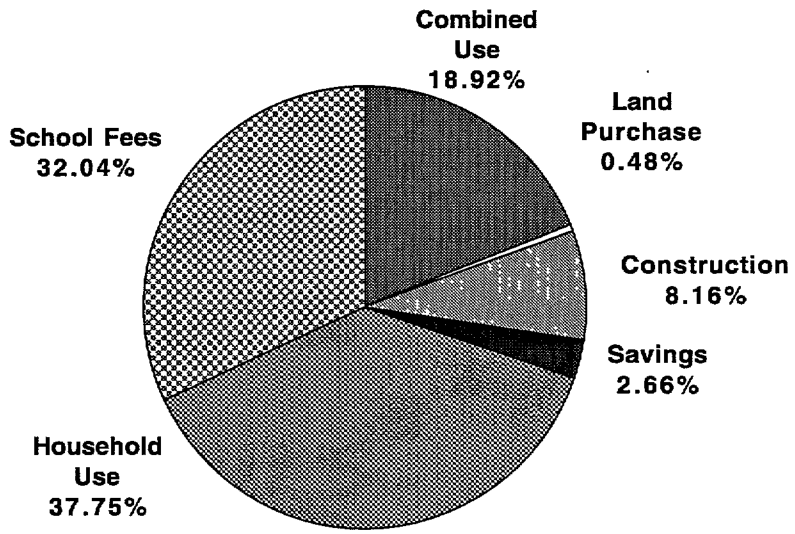


Figure 3: Volume of Credit by Use - Machakos.

for both Machakos and Coast farmers (Njeru, 1997).

Women groups accounted for the largest percentage of lenders providing 42% (KSH 59,960) of all credit and having 33 borrowers in Machakos. Other sources of credit were the Banks which accounted for 25% of the credit, though only two people borrowed. Shops were next with 7% and 7 borrowers, and other sources with 26% by 8 borrowers.

Credit is fragmented at the Coast, meaning that it is difficult to access it. From 23 households, only 30 percent received some credit. One farmer received KSH 3,000 (30%) from a woman's group. Another person received some credit from the Women Finance Trust Fund (a parastatal). Some farmers received items such as corn meal and cooking oil from the shops. These are illustrations of what we mean by fragmentation. Credit knowledge and accessibility differed between the two regions. This is an important difference, as farmers need to identify alternative means of funding if credit markets are fragmented.

Most of the credit received in Machakos was used for general household consumption (38%). School fees took up 32%, followed by livestock, seeds and fertilizer purchases (19%), and construction (8%). Few farmers in Machakos purchased land, most of the households inherited is in Kimutwa. However, in Kitanga, which is newly settled, most farmers purchased their land, and this may explain the small amount of credit used for land purchases. All the credit at the Coast was used for household consumption (Figure 3).

Economic impacts

The monitoring data shows the importance of the KDPG, even though the activity has been in existence for only two and a half years. As Dr. Lutta reported in the preliminary results of the monitoring data, all sites had a

Table 13: Contribution of the KDPG Enterprise to the Farm-Household (Cash and in-kind). Income Expressed in Kenya Schillings, 1995-1996.

	Kitanga	Kimutwa	Kilifi	Vuga	HPI
KDPG					
Weight gains (value in KShs)	1191.00	1258.67	1748.58	1202.48	867.00
KDPG milk (value in KShs)	446.40	235.20	1166.80	364.80	375.60
Sub-total (KDPG)	1637.40	1493.87	2915.01	1567.28	1242.60
Less variable costs	-107.00	-169.00	-308.28	-207.50	-240.00
KDPG (net contribution)	**1530.40**	**1324.87**	**2606.73**	**1359.78**	**1002.60**
Contribution by farm enterprises					
Crops	15969.96	27205.30	8637.00	9758.00	7354.00
Livestock (other than KDPG)	15415.01	22880.58	1514.90	2358.60	13274.60
KDPG	1530.40	1324.87	2606.73	1359.78	1002.60
Total value of farm production	**32915.37**	**51410.75**	**12758.63**	**13476.38**	**21631.20**
Crops %	48.52	52.92	67.69	72.41	33.99
Livestock other than KDPG %	46.83	44.51	11.87	17.50	61.37
KDPG %	**4.65**	**2.58**	**20.43**	**10.09**	**4.63**

Source: Monitoring 1995-1996.

positivenet income effect resulting from the inclusion of the KDPG activity. It is important to note, reflecting on access to credit findings, that the KDPG enterprise generates an important source of income that can not be replaced at this time by credit in the Coast. Levels of net income between the Coast and Machakos are very different, underlining the greater condition of poverty found at the Coast, and therefore the importance of the KDPG enterprise as a mechanism to improve security and diversification.

The KDPG was intended to facilitate access to milk in the case of smallholders. Main findings indicated that farmers at the Coast have the greatest use of goat milk. KDPG milk fluctuated between 20 and 42% of the total produced (Table 13).

Markets: Multiplication and Privatization

This activity was the responsibility of the breeding project. Dr. J. Kogi promoted the KDPG both in Kenya and in the region, with commercial multipliers and grass root organizations. In Kenya, a contract with a third commercial multiplier was established. Social sciences contributed to the instrument to gather information from these multipliers.

Within the plan to regionalize the KDPG, a multiplication research output was formulated (see the Regionalization Proposal of the KDPG). In order to develop this plan, several trips were made to establish linkages with local and international NGOs, and National Research Institutions, as well as ILRI. This proposal developed a participatory plan to regionalize the KDPG approach, as a research tool and a means to contribute to the sustainability of the new breed. The regionalization of the KDPG, which requires financial support, was submitted as a proposal to the SR/GL-CRSP, but was not considered a priority for future activities. Details of the plan and proposed activities in the interface of research and development of livestock projects is in Negotiating Transitions: Small Ruminant Technologies for Zones

Under Pressure in East Africa. It was developed by regional institutions in East Africa and the following ones in the US: Virginia State University (multiplication), Washington State University (animal health), University of Missouri (social and economics impacts and development strategies), Winrock International (feeding and nutrient cycling), and Heifer Project International (development action).

Community Social Networks

This was listed in our workplans for this year. The objective of this analysis was to determine the interaction between the KDPG as an organizing force in the groups of farmers, both at the Coast and Machakos, and the degree of interaction between members, their social networks positive externalities, and results of the pass-on of the KDPG.

Successful economic development projects are currently being correlated to the strengths of communities where they are being implemented. Social networks facilitate access to resources in situations where markets do not function efficiently. The introduction of the KDPG in the Kwale, Kilifi and Machakos districts is based on a community effort, that, in many cases, is a new experience for the community. Some groups have been more successful than others in promoting cooperative actions. It is important to document them in order to understand what actions and factors are important in catalyzing the pass-on mechanism.

Social capital may be defined as the diversity of networks (social) to whom a person, family or household (or community) belongs, allowing access to resources, information or assistance (insurance in case of income shocks). The networks may serve different purposes. Structural adjustment programs in some developing countries motivated the formation of networks to assist families in dealing with the problem of hunger. People's kitchens became popular in poor urban areas. In Andean societies, rural communities that have strong traditions governing rules of access, use and exchange resources and services, contribute to persistence under market failure conditions. The SR-CRSP in a Bolivian peasant community for example, found that the presence of networks allowed families with different levels of wealth access to similar amounts of land (Cala and Jette, Jette and Markowitz). Existence of an active social network also resulted in the construction of facilities, irrigation systems, tap water in the community reducing risk and improving the quality of life. Access to information was also instrumental in seeking funding for development projects for this rural community. In Indian rural societies, spatially dispersed marriages have created networks that protect consumption when income shocks take place (Rosenzweig and Stark). Payment schedules of dowry when marriages take place may be seen from the perspective of developing relationships, because these may be commitments that will last a life time, helping build insurance mechanisms among families from different groups. Networks developed by placing children in urban settings also facilitate access to resources in times of stress (Kusterer). In all, these mechanisms may contribute to the success of development projects.

Progress

This activity was reported in the Annual Report for 1996, as the activities were completed in December of 1996. Further studies on social capital are being conducted at the present (mentioned above). The driving questions were:

1) How have the KDPG pass-on systems contributed to the development of social capital in each cluster? This question was addressed by the study on Goats Groups and Gender (de Haan et al 1996). The positive externality of the KDPG approach in the study was the development of groups that were not present when the research at the sites started.

2) How does social capital (presence of networks, other group organizations, active leaders in the community) contribute to the success of the KDPG or other goat projects through the pass-on system? This research is conducted by Ms. Kyoko Koga for her Master's thesis in agricultural economics, and will be completed in August of 1998. It is hypothesized that differences in the presence and strength of social networks and leadership in the community will be correlated to the level of success of the clusters. The higher the social capital, the more successful the cluster will be in the pass-on and seeking assistance when problems arise. Extended families, ethnic groups, and presence of community organizations to improve infrastructure are forces that can contribute to social capital formation. It is also important to discern if the success of the pass-on is related to the availability of extension and research personnel to the household, training opportunities, education level, or other income generating opportunities.

Case studies of each cluster were developed using an actor oriented approach (de Haan 1996), and participatory rural appraisals techniques were conducted to document the experiences at each site and elicit rules, as perceived by the members, evolving from the original contracts signed with the program. Data collection for this activity started in June, 1996 and was completed at the end of November 1996. The data was entered, a code book developed, and preliminary analysis presented (Njeru, 1997). Analysis includes an account of the history of each community, economic base (resources wealth and activities), and demographic characteristics (de Haan, 1996). Different factors appear to contribute to the success of some clusters and the failure of others. Results will be integrated to the case study analysis of 35 households with KDPGs. Five cases, one corresponding to each cluster on the characteristics of the organization, frequency of meetings, other services provided, and similar group experiences in the village were recorded during 1996. The community organization, benefits, obligations, and mechanisms to deal with problems, as well as perceptions of leaders, members, researchers, and extension officers on the pass-on were analyzed and a report prepared (de Haan et al, 1996). With the data collected and processed at the KDPG clusters, an indicator to measure social capital is being constructed. It integrates information on the composition of the cluster, type of household, access to credit sources, membership in organizations, existence of rules in the present clusters and the degree of recognition, as well as the number of meetings organized (de Haan et al, 1996 and Njeru, 1997). Information from the participatory rural appraisals conducted by social sciences in 1995 and 1996 (Lutta 1997) are also used to develop the indicator.

Activity III: Regionalizing the KDPG Approach to Improve Food and Economic Security

The third major activity proposed in year 18 workplans, was the assessment and development of a full proposal by the Kenya Principal Investigators of the SR-CRSP (the second activity is related to animal health and reported as a separate component). This activity was completed and reported under the section: "Negotiating Transitions: Small Ruminant Technologies for Zones Under Pressure in East Africa".

Training

In Progress

Not currently funded by the SR-CRSP, but working on research themes derived for the Kenya Dual Purpose Goat Research are:

Ms. Dekha Sheikh, Doctoral Degree in Agricultural Economics, University of Missouri-Columbia. Developing Welfare Impact Assessment Methodologies for Livestock Technologies. Estimated date of completion: December of 1998. She is a KARI research officer.

Ms. Nancy Nganga, Master of Science in Agricultural Economics. Returns to Research Investments on Small Ruminant Technologies in Kenya. Estimated Date of Completion: August 1998. She is a KARI research officer funded by the World Bank.

Ms. Grace Njeru. Undergraduate degree in Agricultural Education with emphasis on rural sociology. She is field assistant officer for KARI, and has worked with the KDPG farmers in Machakos. Estimated graduation date: May 1998.

Ms. Nicoline de Haan. Doctoral Degree in Rural Sociology. Funded by University of Missouri and the Brown Fellowship. Groups, Social Capital, Adoption of Livestock Technologies and NGOS. Her research is based in Tanzania in collaboration with Heifer Project International. Estimated date of completion: August 1998.

Ms. Kyoko Koga. Master of Science in Agricultural Economics: Social Capital and the KDPG in Machakos and the Coast. Estimated date of completion: September 1998.

Short Term

Dr. Lutta conducted short term training with the PRAs at the clusters at the Coast and Machakos. He has also given seminars on the use of the instruments developed by the SR-CRSP social sciences to the Socio-economics Division at KARI.

Environmental Impacts and Relevance

Introduction of livestock is carried out with a supporting package to avoid the negative effects encountered in some areas as a result of overgrazing. Use of goat manure is recommended by the package, and is used to enhance the soil.

Agricultural Sustainability

The KDPG is being assessed in two different agroecological environments to test the flexibility and adaptability of the technological innovations. Results show that it is an activity adaptable in both regions, that contributes increased income in poor households with no access to credit.

Contributions to U.S. Agriculture

Experience in interdisciplinary research and micro-enterprise assessment methods are crucial to sustainable production systems design in Africa and in the new rural welfare problems in the U.S.

Contributions to Host Country

Institutional strengthening through training of researchers. Development of interdisciplinary on-farm methodologies for biological and social science research at NARS. Introduction of livestock enterprises increase economic security and promote investments in transitioning market economies. Facilitating the commercial multiplication of the breed, the KDPG, contributes to the sustainability of the technology in the long run. Collaborative research with KARI scientists strengthens both U.S. and Kenyan research institutions, and provides opportunities for exchanges that are long lasting.

Linkages and Networking

This is being developed with NGOs, such as Heifer Project International, to assist in the on-farm multiplication and diffusion of the KDPG. This year Farm Africa and other institutions have been visited to establish linkages for the regionalization of the KDPG, and we established collaboration with them. We developed workshops that brought together more than fifty specialists of the research and development community in East Africa to identify priority areas related to small ruminant technologies.

Gender Analysis

Our household level analysis includes intrahousehold allocation of resources and income domains, as well as decision making. Since a form of impact is on nutrition, and studies show that women outspend men 1 to 30 on food purchases for the children, we have to consider who manages the outputs generated by the KDPG, and look for mechanism to facilitate the flow if it does not already exist. Our research informs the community on the important role women play in the management, not only of the livestock, but many other activities, such as fodder planting and marketing. We also work with women in social sciences research, to improve their access to research activities in their institutions, as recognized by the External Evaluation Panel Report of 1997.

Collaboration with International Centers

The Sociology and Economics Project has based its research on collaboration between Kenyan and U.S. scientists, and among all disciplines participating in the component; collaboration with the private sector (commercial multipliers) and NGOs. This was expanded in the last two years to collaborate with the International Livestock Research Institute in social science research, both on dairy systems and animal health research. We continue this through advising of graduate students.

Support for Free Markets and Broad Based Economic Growth

Growth of in-kind and cash incomes contribute to family welfare, enabling accumulation and diversification to other economic activities, facilitating the development of demand, crucial in economic development. Development of commercial multiplication of the KDPG directly contributes to market development of technologies. The analysis of animal health delivery, as well as demand for animal health services provides information aims at facilitating market development.

Contribution and Compliance with Mission Objectives

Commercialization and micro-enterprise linkages of rural-urban flows, is being emphasized by the USAID Kenya Mission. Our research is looking into privatization and community organizations, as well as safety-net mechanisms that will contribute producer's participation in the markets. The KDPG commercial multiplication is an important example of how USAID funds contributes to the development of commercial production and markets.

Concern for Individuals

The focus of our research are smallholder families, mostly poor and in rural settings; our objective is to find ways to increase their welfare through technology and policy. Measuring the impact of the KDPG may be performed from the perspective of how this effort/ event in their village, contributes to the development of networks that create other positive externalities. Our research has positive effects for individuals as they increase their interaction as a group and build their social networks. The KDPG may catalyze the process of constructing networks outside the extended family setting, building social capital.

Support for Democracy

Improving the economic and nutritional well being of individuals, especially if women and children are targeted through the KDPG, may increase their safety net and ability to participate in decisions and the economy. The KDPG has also increased the ability of farmers to organize and seek other projects, helping build social capital.

Humanitarian Assistance

Our research focuses on means that will allow farmers to help themselves. We recognized grass root organizations as important to this process, therefore, the focus on collaboration with non-governmental organizations that assist rural poor families.

Comments

The funding this year was $85,000, which was used to carry out the workplans for the KDPG component, the Animal Health Through Biotechnology research, and the regionalization proposal of the KDPG. It was through matching funds and other resources that the activities listed were accomplished, and the remaining will be completed.

Corinne Valdivia, Principal Investigator for this project, specially wants to thank Michael F. Nolan, Unit Leader of the Social Sciences Unit at the University of Missouri-Columbia, for his constant support both morally and financially of our research project, and the people involved. He has been an excellent role model for me as person and Principal Investigator in the SR-CRSP.

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Corinne Valdivia, Research Assistant Professor, University of Missouri-Columbia

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Jim Yazman, Senior Officer, Winrock International

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PROJECT EXPENDITURES

Small Ruminant CRSP
USAID Grant No. DAN-1328-G-00-0046-00
Expenditures by Program

Institutions	Disciplines	Year 12 90/91	Year 13 91/92	Year 14 92/93	Year 15 93/94	Year 16 94/95	YEAR 17 95/96	YEAR 18 96/97	Total
Univ. of Ca., Davis	Genetics	$331,324.81	$321,288.16	$253,754.00	$178,367.45	$49,738.66	$18,257.07	$0.00	$1,152,730.15
Univ. of Ca., Davis	Agric. Econ	$0.00	$0.00	$0.00	$0.00	$0.00	$18,411.18	$0.00	$18,411.18
Univ. of Ca., Davis	Range Mgmt							$100,557.05	$100,557.05
Univ. of Ca., Davis	Nutrition							$90,441.83	$90,441.83
UCLA	Nutrition							$106,687.00	$106,687.00
Colorado State	Animal Hlth	$179,497.99	$195,474.36	$137,000.00	$0.00	$0.00	$0.00	$0.00	$511,972.35
Colorado State	Natl Res. Mgm							$109,981.82	$109,981.82
Univ. of Missouri	Sociology	$201,575.76	$353,614.61	$345,687.42	$217,925.32	$132,324.00	$179,530.00	$85,000.00	$1,515,657.11
Montana St Univ	Breeding	$110,568.80	$105,196.99	$0.00	$0.00	$0.00	$0.00	$0.00	$215,765.79
Cornell University	Land Use							$63,052.10	$63,052.10
N. Carolina St Univ	Nutrition	$383,672.90	$337,642.00	$303,258.17	$305,833.06	$104,548.00	$0.00	$0.00	$1,434,954.13
Texas A&M Univ.	Breeding	$141,524.58	$194,460.00	$165,750.00	$150,321.83	$79,135.00	$166,525.00	$84,789.38	$982,505.79
Texas A&M Univ.	Info Sys							$129,475.40	$129,475.40
Texas A&M Univ.	GIS							$130,855.25	$130,855.25
Texas Tech. Univ.	Range-Nutr	$84,122.34	$191,010.28	$168,446.05	$132,179.41	$0.00	$0.00	$0.00	$575,758.08
Utah State Univ.	Range-Eco	$91,342.42	$133,195.00	$142,270.00	$165,870.00	$100,327.93	$39,000.00	$9,191.86	$681,197.21
Utah State Univ.	Risk Mgmt.							$90,290.84	$90,290.84
Wash St Univ.	Health	$160,000.00	$175,000.00	$146,000.00	$197,061.34	$204,073.64	$193,974.87	$87,999.48	$1,164,109.33
Winrock Int'l.	Dairy Mgmt.	$233,000.00	$186,690.00	$126,318.17	$78,290.76	$42,014 00	$115,979.19	$77,939.42	$860,231.54
Winrock Int'l.	Economics	$212,325.07	$246,906.00	$187,000.00	$173,095.25	$128,125.00	$225,587.19	$21,690.00	$1,194,728.51
Univ. of Wisc	Networkg	$0.00	$0.00	$28,779.79	$13,829.53	$0.00	$0.00	$0.00	$42,609.32
Univ. of Wisc	Socio-Econ							$154,669.04	$154,669.04
Univ. of Wisc	Natl Resource							$104,641.20	$104,641.20
Univ. of Kent	Anthro	$0.00	$0.00	$0.00	$0.00	$0.00	$23,659.34	$0.00	$23,659.34
	Subtotal	$2,128,954.67	$2,440,477.40	$2,004,263.60	$1,612,773.95	$840,286.23	$980,923.84	$1,447,261.67	$11,454,941.36
HOST COUNTRIES *									
Indonesia		$0.00	$0.00	$7,099.00	$0.00	$81,464.25	$0.00	$0.00	$88,563.25
Kenya		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$20,000 00	$20,000.00
Morocco		$14,609.18	$10,756.76	$0.00	$0.00	$0.00	$0.00	$0.00	$25,365.94
Bolivia		$42,656 96	$147,330.90	$46,241.74	$34,656.64	$93,290.74	$15,192.28	$0.00	$379,369.26
	Subtotal	$57,266.14	$158,087.66	$53,340.74	$34,656.64	$174,754.99	$15,192.28	$20,000.00	$513,298.45
Management Entity	**	$439,035.03	$498,501.98	$658,193.61	$422,137.36	$297,538.46	$512,194.45	$452,843.12	$3,280,444.01
Small Grants		$0.00	$0.00	$0.00	$0.00	$0.00	$38,423.91	$0.00	$38,423.91
	Subtotal	$439,035.03	$498,501.98	$658,193.61	$422,137.36	$297,538.46	$550,618.36	$452,843.12	$3,318,867.92
	TOTAL	$2,625,255 84	$3,097,067.04	$2,715,797.95	$2,069,567.95	$1,312,579.68	$1,546,734.48	$1,920,104.79	$15,287,107.73

**** Most Host Country Expenses are reflected in the expenditures for the participating U.S. institutions.***

***** Expenditure for ME includes expenses for EEP, Board Meetings, Technical Committee and other meetings.***

SMALL RUMINANT CRSP
USAID GRANT NO. DAN-1328-G-00-0046-00
APPROVED PROGRAM BUDGETS

Institutions	Disciplines	Year 12 90/91	Year 13 91/92	Year 14 92/93	Year 15 93/94	Year 16 94/95	Year 17 95/96	Year 18 96/97	Total
Univ. of Calif., Davis	Genetics	$281,246.00	$233,000.00	$185,000.00	$223,167.00	$49,876.00	$50,000.00	$0.00	$1,022,289.00
Univ. of Calif., Davis	Agric. Econ.	$0.00	$0.00	$0.00	$0.00	$0.00	$18,661.00	$0.00	$18,661.00
Univ. of Calif , Davis	Range Mgmt.	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$135,817.00	$135,817.00
Univ. of Calif., Davis	Nutrition	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$99,878.00	$99,878.00
UCLA	Nutrition	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$106,687.00	$106,687.00
Colorado State	Animal Health	$201,570.00	$175,000.00	$137,000.00	$0.00	$0.00	$0.00	$0.00	$513,570.00
Colorado State	Ecology	$0 00	$0.00	$0.00	$0.00	$0.00	$0.00	$117,678.00	$117,678.00
Cornell University	Animal Nutr.	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$92,891.00	$92,891.00
Univ. of Missouri	Sociology	$313,500.00	$202,442.00	$210,000.00	$266,780.00	$132,324.00	$179,530.00	$85,000.00	$1,389,576.00
Montana State Univ.	Breeding	$113,025.00	$106,412.00	$0.00	$0.00	$0.00	$0.00	$0.00	$219,437.00
N. Carolina State Univ.	Nutrition	$295,000.00	$227,000.00	$195,000.00	$352,100.00	$104,548.00	$60,000.00	$0 00	$1,233,648.00
Texas A&M Univ.	Breeding	$210,659.00	$140,000.00	$129,000.00	$167,000.00	$79,135.00	$166,525.00	$85,000.00	$977,319.00
Texas A&M Univ.	Drought GIS	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$130,930.00	$130,930.00
Texas A&M Univ.	Info Systems	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$138,543.00	$138,543.00
Texas Tech. Univ.	Range-Nutr.	$180,000.00	$115,000.00	$118,000.00	$170,000.00	$0.00	$0.00	$0.00	$583,000.00
Utah State Univ.	Range-Ecology	$120,000.00	$115,000.00	$115,000.00	$165,870.00	$114,804.00	$39,000.00	$110,973.00	$780,647.00
Washington State Univ.	Health	$160,000 00	$175,000.00	$146,000.00	$304,327.00	$204,435.00	$196,000.00	$88,000.00	$1,273,762.00
Winrock Int'l.	Dairy Mgmt.	$200,000.00	$150,000.00	$107,000.00	$82,500 00	$42,014.00	$138,000.00	$85,000.00	$804,514.00
Winrock Int'l.	Economics	$255,000.00	$202,558.00	$177,000.00	$205,000.00	$128,125.00	$228,600.00	$21,690.00	$1,217,973.00
Univ. of Wisconsin	Networking	$0.00	$0.00	$40,000.00	$55,000.00	$0.00	$0.00	$0.00	$95,000.00
Univ. of Wisconsin	Socio-Econ	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$141,247.00	$141,247.00
Univ. of Wisconsin	Natural Res.	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$104,655.00	$104,655.00
Univ. of Kentucky	Anthropology	$0.00	$0.00	$0.00	$0.00	$0.00	$23,669.00	$0.00	$23,669.00
	Subtotal	$2,330,000.00	$1,841,412.00	$1,559,000.00	$1,991,744.00	$855,261.00	$1,099,985.00	$ 1,543,989.00	$11,221,391.00
Management Entity*		$600,000.00	$610,000.00	$610,000.00	$524,275.00	$311,813.00	$600,294.00	$ 442,030.00	$3,698,412.00
Program Enhancement Funds		$0.00	$43,588.00	$40,000.00	$15,000.00	$71,479.41	$56,021.00	$ 441,199.00	$667,287.41
Host Countries		$310,000.00	$305,000.00	$206,500.00	$41,620.00	$106,293.00	$15,273.00	$ 20,000.00	$1,004,686.00
Linkages/workshops		$65,000.00	$0.00	$70,000.00	$0.00	$0.00	$0.00	$62,750.00	$197,750.00
Impact Assessment		$0.00	$0.00	$0.00	$3,133.00	$0.00	$0.00		$3,133.00
Networks		$0.00	$0.00	$14,700.00	$0.00	$0.00	$0.00		$14,700.00
Funds for Student Training		$0.00	$0.00	$0.00	$20,000.00	$874.00	$0.00		$20,874.00
New Site/Activity/Grant Renewal		$0.00	$0.00	$459,800.00	$19,000.00	$75,000.00	$266,389.00	$ 30,000.00	$850,189.00
	Subtotal	$975,000.00	$958,588.00	$1,401,000.00	$623,028.00	$565,459.41	$937,977.00	$ 995,979.00	$6,457,031.41
Small Grants						$12,540.00	$40,160.00	$ 15,000.00	$67,700.00
Publications						$6,089.00	$8,770.00	$ 19,795 00	$34,654.00
	Subtotal					$18,629.00	$48,930.00	$ 34,795 00	$102,354.00
	TOTAL	$3,305,000.00	$2,800,000.00	$2,960,000.00	$2,614,772.00	$1,439,349.41	$2,086,892.00	$ 2,574,763.00	$17,780,776.41

*** Allocation for ME includes funding for External Evaluation Panel, Board Meetings, Technical Committee, and other meetings.***

Small Ruminant CRSP
USAID Grant No. DAN-1328-G-00-0046-00
Summary of Host Country Contributions

Host Country	Year 12 90/91	Year 13 91/92	Year 14 92/93	Year 15 93/94	Year 16 94/95	Year 17 95/96	Year 18 96/97	Total
Bolivia	$809 00	$164,787.00	$81,230.00	$117,013.48	$125,764.12	$0.00	$0.00	$489,603.60
Indonesia	$1,428,400.00	$3,691,400.00	$4,692,840.00	$5,004,400.00	$4,999,800.00	$5,012,500.00	$0.00	$24,829,340.00
Kenya	$218,771.00	$216,284.00	$127,919.00	$56,489.00	$254,718.00	$280,995.00	$308,565.00	$1,463,741.00
Morocco	$1,044,000.00	$826,000.00	$811,000.00	$0.00	$0.00	$0.00	$0.00	$2,681,000.00
Peru	$6,845.00	$6,500.00	$0.00	$0.00	$0.00	$0.00	$0.00	$13,345.00
TOTAL	$2,698,825.00	$4,904,971.00	$5,712,989.00	$5,177,902.48	$5,380,282.12	$5,293,495.00	$308,565.00	$29,477,029.60
Non-CRSP Support	$46,615.00	$120,962.00	$166,259.00	$340,472.00	$84,301.00	$0.00	$0.00	$758,609.00
TOTAL	$2,745,440.00	$5,025,933.00	$5,879,248.00	$5,518,374.48	$5,464,583.12	$5,293,495.00	$308,565 00	$30,235,638.60

Small Ruminant CRSP
USAID Grant No. DAN-1328-G-00-0046-00
Matching Contributions From U.S. Institutions

Institution	Disciplines	Year 12 90/91	Year 13 91/92	Year 14 92/93	Year 15 93/94	Year 16 94/95	Year 17 95/96	Year 18 96/97	Total
Univ. of Calif, Davis	Genetics	$118,292.08	$122,877.02	$103,056.00	$92,682.00	$36,282.00	$18,951.36	$0.00	$492,140.46
Univ. of Calif, Davis	Agric Econ.	$0.00	$0.00	$0.00	$0.00	$0 00	$0.00	$0.00	$0.00
Univ. of Calif, Davis	Nutrition	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$40,000.00	$40,000.00
Univ. of Calif., Davis	Range Conservat	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$25,000.00	$25,000.00
UCLA	Nutrition	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$37,701.00	$37,701.00
Colorado State	Animal Health	$53,333.04	$87,499.62	$41,861.38	$0.00	$0.00	$0.00	$0.00	$182,694.04
Colorado State	Nat'l Resource	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$37,151.56	$37,151.56
Cornell University	Land Use	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$216,176.00	$216,176.00
Univ. of Missouri	Sociology	$66,184.42	$81,894.67	$121,900.45	$91,115.58	$33,601.39	$51,541.90	$36,739.05	$482,977.46
Montana State Univ	Breeding	$60,734.04	$52,668.00	$0.00	$0.00	$0.00	$0.00	$0.00	$113,402.04
No Carolina St Univ	Nutrition	$64,731.14	$55,975.10	$53,631.00	$55,192.79	$20,331.83	$0.00	$0.00	$249,861.86
Texas A&M Univ	Breeding	$46,289.63	$53,757.88	$63,822.49	$63,704.89	$25,303.42	$46,172.71	$20,151.32	$319,202.34
Texas A&M Univ	Info Systems	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$33,042.00	$33,042.00
Texas A&M Univ	GIS	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$32,000.00	$32,000.00
Texas Tech Univ	Range-Nutrition	$51,422.63	$68,212.94	$49,900.38	$45,924.26	$0.00	$0.00	$0.00	$215,460.21
Utah State Univ	Range Ecology	$46,379.09	$84,756.83	$52,639.90	$54,737.10	$73,152.99	$9,750.00	$3,584.83	$325,000.74
Utah State Univ	Range Risk Mgmt	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$14,673.05	$14,673.05
Wash St Univ	Health	$53,333.00	$81,373.76	$48,180.00	$120,470.61	$85,296.23	$117,106.12	$25,412.76	$531,172.48
Winrock Int'l.	Economics	$75,406.90	$83,273.79	$102,045.27	$92,258.89	$71,268.24	$65,431.43	$19,992.60	$509,677.12
Winrock Int'l.	Dairy Mgmt.	$68,022.61	$56,749.01	$26,262.35	$47,138.48	$26,750.68	$33,149.03	$41,036.81	$299,108.97
Univ. of Wisc.	Natl Resource	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$130,816.77	$130,816.77
Univ. of Wisc.	Socio-Econ.	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$190,996.48	$190,996.48
Univ of Wisc	Networking	$0.00	$0.00	$0.00	$11,795.61	$0.00	$0.00	$0.00	$11,795.61
Univ of Kentucky	Anthropology	$0.00	$0.00	$0.00	$0.00	$0.00	$4,715.00	$0.00	$4,715.00
	TOTAL	$704,128.58	$829,038.62	$663,299.22	$675,020.21	$371,986.78	$346,817.55	$904,474.23	$4,494,765.19
	Percentage	32.21%	31.90%	32.24%	40.97%	36.65%	22%	47%	29%

GLOSSARY

AARD	Agency for International Research and Development, Indonesia
AAU	Addis Ababa University
ABS	American Breeders Society
ACIAR	Australian Centre for International Agricultural Research
ADG	Average daily gain
AFPC	Agricultural and Food Policy Center
AFRNET	African Feed Resources Network
AGRIS	International Information System for the Agricultural Sciences and Technology, FAO
AID	Agency for International Development, Washington D.C., USA
AIGACAA	Asociacion Integral de Ganadevos en Camelidos de los Andes Altos
ALRMP	Arid Lands Resource Management Project
AMREF	African Medical Research Education Foundation
ANP	Applied Nutrition Program
ANPP	Annual Net Primary Productivity
AP	Animal Production
ARC	Agriculture Research Council
ARD	Association for Rural Development
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
ASF	Animal Source Foods
ASP	Agrosilvopastoral
ASPADERUC	Asociacion para el Dasarolla Rural de Cajamarca
AT	Assessment Team

ATI	Appropriate Technology International
ATW	Assessment Team Workshop
AWF	American Wildlife Federation
B	Barbados Blackbelly Sheep
BASIS CRSP	Broadening Access and Strengthening Market Input Systems Collaborative Research Support Program
BC	Barbados x Sumatra Sheep
BIFAD	Board for International Food and Agriculture Development
BPP	National Rubber Research Institute, Indonesia
BPT	Balai Penelitian Ternak, Bogor, Indonesia (Animal Husbandry Research Institute)
BR	Basic Resources
BW	Body weight
CAP	Common Agricultural Policy
CAR	Central Asian Republics
CARDI	Caribbean Agricultural Research and Development Institute
CARE	Cooperative for American Remittance to Europe, Inc.
CATIE	Centro Agronomico Tropical de Investigacion y Ensenaza
CBE	Commercial Bank of Ethiopia
CBPP	Contagious Bovine Pleuropneumonia
CCPP	Contagious Caprine Pleuropneumonia
CDC	Centro de Datos para la Conservacion
CEDEP	Centro de Estudios para d'Oesarrollo y la Participacion
CER-DET	Centro de Estudios Regionales para el Desarrollo de Tarija
CGIAR	Consultative Group on International Agricultural Research
CHDC	Child Health and Development Center
CIAT	Centro Internacional de Agricultura Tropical
CIDICCO	Centro Internacional de Informacion Sobre Cultivos de Cobertura
CIEC	Centro Interdisciplinario de Estudios Comunitarios

CIESTAAM	Center for Economic, Social, and Technology Research on World Agriculture and Agribusiness
CIP	Centro Internacional de la Papa - International Potato Center
C/LAA	Caribbean/Latin American Action
CLAS-UMSS	Centro de Levantamientos Aerospaciales y Aplicaciones de SIG
CNA	Confederacion Nacional Agropecuario
CNCPS	Cornell Net Carbohydrate and Protein System
CNG	Confederacion Nacional Ganadera
CONDESAN	Consorcio para el Desarrollo Sostenible de la Ecoregion Andina
CORAF	Conference de la Recherche Agronomique des Responsable Africains et Francais
CP	Crude protein
CPV	Capripox virus
CRES	Center for Resource and Environmental Studies
CRIAS	Coordinating Research Institute for Animal Science, Indonesia
CRSP	Collaborative Research Support Program
CSIRO	Commonwealth Scientific and Industrial Research Organization
CSU	Colorado State University
CT	condensed tannins
CURLA	Centro Universitario Regional del Litoral Atlantico
d	day
DANIDA	Danish International Development Agency
DOM	Digestible Organic Matter
DM	Dry Matter
DPG	Dual Purpose Goat
DPIRP	Drought Preparedness Intervention and Recovery Program
DSS	Decision Support System
EE	Effective Environment
EEC	European Economic Community

EEP	External Evaluation Panel
EHNRI	Ethiopian Health and Nutrition Research Institute
ELISA	Enzyme linked immunosorbent assays
EMBRAPA	Brazilian National Agency for Agricultural Research
ENNIV	Peruvian Living Standards and Measurement Survey
ENSO	El Nino and Southern Oscillation
EPG	Eggs per Gram
EPIC	Erosion Productivity Import Calculator
EU	Edgerton University
EW	Extension Worker
FA	FARM Africa
FAO	Food and Agriculture Organization, United Nations
FCC	Fertility Capability Classification System
FD	Full-day
FEWS	Famine Early Warning System
FIRA	Fideicomisos Instituidos en Relacion con la Agricultura
FLACSO	Facultad Latinoamericana de Ciencias Sociales
FMD	Foot and Mouth Disease
FOSS	First in Food Analysis
FUNAN	Fundacion Antisana
GANL	Grazingland Animal Nutrition Laboratory
GIS	Geographic Information System
GO	Government Organization
GPS	Global Positioning Systems
GSE	Greater Serengeti Ecosystem
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit (German Agency for Technical Cooperation)
h	hour
H	St. Croix Sheep

ha	Hectare
HC	St. Croix x Sumatra Sheep
HEM	Hemicellulose
HH	Household
HPI	Heifer Project International
HSPC	Human Subject Protection Committee
HW	Health Worker
IADB	Inter-American Development Bank
IAP-MU	International Agriculture Programs - Missouri University
IAR	Institute for Agricultral Research
IARC	International Agricultural Research Center
IBTA	Instituto Boliviano de Technologia Agropecuaria
ICA	Instituto Colombiano Agropecuaria, Colombia
ICARDA	International Centre for Agricultural Research in the Dry Areas
ICIPE	International Centre of Insect Physiology and Ecology
ICRAF	International Centre for Research on Agroforestry
ICRISAT	International Crops Research Institute for the Semiarid Tropics
ICRW	International Center for Research on Women
IDIAP	Agricultural Research Institute of Panama
IDRC	International Development Research Centre (Canada)
IEMUT	French Tropical Veterinary Institute
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IGADD	International Governmental Authority on Drought and Development
IICA	Interamerican Institute for Cooperation in Agriculture
IIML	Integrated Information Management Laboratory
IIN	Instituto Investigacion Nutricional
ILRAD	International Laboratory for Research on Animal Diseases
ILRI	International Livestock Research Institute

IMAS	Integrated Modeling and Assessment System
IMECBIO	Instituto Manantian de Ecologia y Conservation de la Biodeversidad
INCALAC	Industria Cajamarquina de Lacteos
INCAP	Instituto de Nutricion para Centro America y Panama
INEGI	Instituto de Estadistica, Geografia e Informatica
INIA	Instituto Nacional de Investigacion Agrarias
INIFAP	Instituto Nacional de Investigaciones Forestales y Agropecuarios
IP2TP	Installation for Research and Assessment of Agricultural Technology
IPB	Bogor Agricultural University
ISLP	Integrated Small Livestock Project
ISNAR	International Service for National Agricultural Research
JESS	Jubba Environmental and Socioeconomic Studies
KARI	Kenya Agricultural Research Institute
KCB	Kenya Commercial Bank
KDPG	Kenya Dual Purpose Goat
KDRSRS	Kenya Department of Resource Surveys and Remote Sensing
KEVEVAPI	Kenya Veterinarian Vaccine Production Institute
kg	kilogram
KLDP	Kenya Livestock Development Program
KNP	Katavi National Park
KRTISB	Kazakh Research and Technological Institute of Sheep Breeding
Ksh	Kenya Shilling
KUSCCO	Kenya Union of Savings and Credit Cooperatives
KWS	Kenya Wildlife Service
KWVA	Kenya Women's Veterinary Association
LAC	Latin American Countries
LAI	Leaf Area Index

LDC	Lesser Developed Country
LEWS	Livestock Early Warning System
LINDA	Livestock Information Network Development for the Americas
LPRI	Livestock Production Research Institute
LS	Livestock
LU	Livestock Units
M	Composite Population Sheep: 25% St. Croix, 25% Barbados Blackbelly, 50% Sumatran Sheep
MALDM	Ministry of Agriculture, Livestock Development and Marketing
MCF	Malignant Catarrhal Fever
ME	Management Entity
MIAC	MidAmerica International Agricultural Consortium
MOA	Ministry of Agriculture
MOH	Ministry of Health
MOU	Memorandum of Understanding
MUCIA	Midwest Universities Consortium for International Agriculture
NAARI	Namulaonge Agricultural and Animal Production Research Institute
NAFTA	North American Free Trade Agreement
NARO	National Agricultural Research Organization
NARS	National Agricultural Research System
NCA	Ngorongoro Conservation Area
NCRSP	Nutrition Collaborative Research Support Program
NCSU	North Carolina State University
NDF	Neutral detergent fiber
NDVI	Normalized Difference Vegetation Indices
NES	Nucleus Estate Smallholder
NFTA	Nitrogen Fixing Tree Association
NGO	Non-Governmental Organization

NIH	National Institute for Health
NIRS	Near Infrared Reflectance Spectroscopy
NIS	Newly Independent States
NOAA	National Oceanographic and Atmospheric Administration
NRC	National Research Council
NRCS	Natural Resources Conservation Service
NREL	Natural Resource Ecology Laboratory
NRN	Natural Resources Network
NSDV	Nairobi Sheep Disease Virus
NSF	National Science Foundation
OAU	Organization of African Unity
ODA	Overseas Development Administration
ODI	Overseas Development Institute
OMD	Organic Matter Digestibility
OMI	Organic Matter Intake
OPC	Ovine pulmonary carcinoma
OPMM	Outreach Research Project at Membang Muda
OPP	Outreach Pilot Project
OPS	Outreach Project for the Sosa
ORP	Outreach Research Project
OvLV	Ovine lentivirus
PA	Participatory Appraisal
PAC	Program Advisory Committee
PAR	Photosynthetic Active Radiation
PCV	Packed Cell Volume
PEM	Protein-Energy Malnutrition
PENHA	Pastoral and Environmental Network in the Horn of Africa
PI	Principal Investigator
PL480	Public Law No. 480

PM	Problem Model
PRA	Participatory Rural Appraisals
PROMETA	Proteccion del Medio Ambiente Tarija
PRR	Proyecto de Reconstrucion Rural
PSICA	Information System and Agricultural Census Project
PVO	Public Volunteer Organization
RAINAT	Research and Assessment Installation for Agricultural Technology
REDSO	East African Region US AID
RERUMEN	Latin American Network of the Small Ruminant CRSP
RF	Range Forage
RFA	Request for Assistance
RFP	Request for Proposals
RGR	Rukwa Game Reserve
RH	Relative Air Humidity
RIAP	Research Institute for Animal Production, Bogor, Indonesia
RISPAL	Latin American Network for Animal Production Systems Research, IDRC
RS	Remote Sensing Technologies
RS	Resident Scientist
RSG	Ranching Systems Group
RVFV	Rift Valley Fever Virus
S	Sumatra Sheep
SA	Small Animals
SACCAR	Southern African Centre for Cooperation in Agricultural Research
SAGAR	Secretaria de Agricultural, Ganaderia y Desarrollo Rural
SALTLICK	Semi-Arid Lands Training and Livestock Improvement Centres of Kenya

SARI	Selian Agricultural Research Institute
SBPT	Balai Penelitian Ternak, Sei Putih, Indonesia (Animal Husbandry Research Institute)
SCT	Spatial Characterization Tool
SE	Socio-Economic
SEAD	Servicios de Apoyo al Desarrollo
SECOFI	Secreatria de Comercio
SEMARNAP	Servicio Nacional del Medio Ambiente, Recursos Naturales y Pesca
SES	Socio-economic Status
SICA	Proyecto Censo Agropecuario y Sistema de Informacion
SNIM	Servicio Nacional de Informacion de Mercados
SR-CRSP	Small Ruminant Collaborative Research Support Program
SRNET	Pan-African Small Ruminant Research Network
SRUPNA	Small Ruminant Production Systems Network for Asia
T	Temperature
TA	Technological Alternatives
TACIS	Technical Assistance to the Commonwealth of Independent States
Tair	Air Temperature
TANAPA	Tanzania National Parks
TAMU	Texas A&M University
TDN	Total digestible nutrients
TE	Terraneuva
Techpac	Technology Package
Tsoil	Soil Temperature
TT	Technology Transfer
UACh	Autonomous University of Chapingo
UCD	University of California, Davis
UCR	University of Costa Rica

UCV	Universidad Central de Venezuela, Maracay
UMC	University of Missouri-Columbia
UN	University of Nairobi
UNALM	Universidad Nacional Agraria La Molina
UNAM	Universidad Nacional Autonoma de Mexico
UNDOS	United Nations Development Office for Somalia
UNDP	United Nations Development Program
UNICEF	United Nations Children's Fund
UNMSM	Universidad Nacional Mayor de San Marcos
USAID	United States Agency for International Development
USAMRID	United States Army Medical Research Inst. of Infectious Disease
USDA	United States Department of Agriculture
USGS	United States Geological Survey
USU	Utah State University
UW	University of Wisconsin
UWI	University of West Indies
VOCA	Volunteers in Overseas Cooperative Assistance
WAN	Wide Area Network
WHO	World Health Organization
WMO	World Meterological Organization
WSU	Washington State University
WI	Winrock International Institute for Agricultural Development
WILD	Women in Livestock Development
WINS	Women Infant Nutrition Support
Wsoil	Soil Moisture
WTO	World Trade Organization
WWF	World Wildlife Fund
ZONISIG	Proyecto Zonification Agro-ecologica y Establecimients de una Base de Datos y Red de Sistema de Informacion

OVERSIGHT GROUPS

Global Bureau, United States Agency for International Development (USAID)
Board for International Food and Agricultural Development and Economic Cooperation (BIFADEC)
Joint Committee on Research and Development (JCORD)

U.S. INSTITUTIONS

Baylor College of Medicine, Texas
California Poly Technical State Univ., San Luis Obispo
Colorado University
Cornell University
Danone Company
Associates for Rural Development Inc., Vermont
Global Knowledge Group
Heifer Project International
Houston Livestock Show and Rodeo
International Food Policy Research Institute
Oklahoma State University
Pennsylvania State University
Texas A&M University System
Texas Agricultural Extension System
University of California, Davis
University of California, Los Angeles
University of Kentucky
University of Missouri-Columbia
University of Wisconsin-Madison
Utah State University
U.S. Army Medical Research Insti.of Infectious Diseases
U.S. Department of Agriculture
USDA-NRCS Grazinglands Technology Institute
Virginia State University
Washington State University
Winrock International Insti. for Agricultural Development

INTERNATIONAL INSTITUTIONS

Central Asia

Institute of Animal Breeding and Veterinary, Turkmenistan
Institute of Ecology and Sustainable Development, Kazakhstan
Ministry of Agriculture Samarkand State University, Uzbekistan
Institute of Space Research, Kazakhstan
International Center for Agricultural Research in the Dry Areas (ICARDA)
Kazakh Institute for Hydrometerological Research
Kazakh Institute of Oriental Studies, Ministry of Sciences
Kazakh Research Institute of Feed and Pasture
Karakul Sheep Husbandry Institute, Kazakhstan
National Federation of Private Farmers of Kazakhstan
Overseas Development Institute, United Kingdom

Latin America

Belize Ministry of Agriculture and Fisheries
Centro de Estudios Regionales para el Desarrollo de Tarija, Bolivia
Centro de Datos para la Conservacion (CDC), Ecuador
Centro Internacional de la Papa (CIP)
CONDESAN, Peru
Fundacion Antisana (FUNAN), Ecuador
Interamerican Institute for Cooperation on Agriculture (IICA)
Instituto de Investigacion Nutricional, Peru
Universidad de Guadalajara, Mexico
Panamerican Agriculture School El Zamorano, Honduras
Proteccion del Medio Ambiente Tarija (PROMETA), Bolivia
Purina, S.A., Mexico
Servicios de Apoyo al Desarrollo (SEAD), Bolivia
Terranueva, Ecuador
Universidad Nacional Agraria La Molina, Peru

East Africa

Alemaya University, Ethiopia
Association for Strengthening Agriculatural Research in Eastern and Central Africa (ASARECA)
Busoga Diocese, Uganda
CARE-Ethiopia
Evangelical Lutheran Church of Tanzania
FARM-Africa, Ethiopia
International Center for Research in Agroforestry (ICRAF)
International Livestock Research Institute (ILRI)
Joy Children Center, Uganda
Kenya Agricultural Research Institute (KARI)
Livestock Production Research Institute, Tanzania
Makerere University, Uganda
National Agricultural Research Organization (NARO)
Pastoral and Environmental Network in the Horn of Africa
Rockefeller Foundation, Kenya
Selian Agricultural Research Institute
Sokoine University of Agriculture, Tanzania
Uganda Ministry of Wildlife and Antiquities
University of Cape Town, South Africa
University of Dar es Salaam, Tanzania
University of Nairobi, Kenya
World Vision, Tanzania