

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

### NARRATIVE SUMMARY

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

Spatial stratification of regions forms the sampling frame for defining “effective environments” or climatic clusters where sampling points are assigned throughout a given monitoring zone. Specification of actual monitoring points is targeted for maximum impact and representation of variations across the region. The focus is on accessible pastoral households, which share common climatic, edaphic, and production system attributes distributed throughout a region. For each sampling point, dominant landscapes are

assigned modal or typical plant community which would fill the “pixel” of the 8x8 km grids generated from the METEOSAT satellite data and the AVHRR NDVI greenness data.

Once a sampling point has been defined (geo-referenced) and modal vegetation characterized, herd populations are estimated based on the sample of the household herd and known livestock population densities in the grazing radius of the household. In zones with sufficient human resources within the network, fecal samples are collected monthly from these households, sent to a national NIRS fecal profiling lab to determine diet protein and energy, and ultimately projections are made for animal performance and body condition, with advisories provided to the livestock owners, pastoral organizations, and village institutions.

Critical to the process is automation of the modeling process of linking biophysical models with satellite monitoring weather systems in collaboration with FEWS NET, EROS, and NOAA RFE satellite-based weather data. These automated products are found on the following web sites <http://cnrit.tamu.edu/aflews> and <http://cnrit.tamu.edu/rsg/rainfall/rainfall.cgi> in which daily deviations in forage production are computed along with daily satellite weather and dekadal NDVI or greenness data, processed by Texas A&M University Center for Natural Resource Information Technology and the ASARECA Crisis Mitigation Office. Model output is

channeled through key regional organizations, national EW agencies, district officers, NGOs, and community-based organizations.

## RESEARCH

**Problem Statement.** Recurrent drought and famine, followed by floods, are regular features that induce limitations within the natural environment in East Africa. The chances of drought occurring in parts of the Greater Horn have increased from a probability of one in six years to one in three years for areas affected. Repeated occurrences of drought and high variability in precipitation have reduced the ability of many small holders, such as pastoralists, to maintain their assets or respond when conditions are good. The phenomenon reduces livestock productivity and threatens food security of pastoral communities in the regions. Other natural disasters, such as pest infestations and periodic flooding, destroy area-specific production levels. Migration, as a coping mechanism, causes conflict/ethnic strife over available resources, such as grazingland and water. 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 desire to respond to warning signs of all kinds. The current set of weather and remote sensing information generated by donor-based monitoring programs (e.g. NOAA RFE, NASA NDVI) offers information on locations of “initiating conditions” while the on-ground monitoring programs of markets, human conditions, and animal herd situations mainly reflect a “post-effect” appraisal system. However, many of the problems besetting livestock (e.g., weight and body condition loss)

have already occurred before the human eye can detect the response. Other human indicators are further down the food chain within the pastoral ecosystem and offer even more delayed post-effect monitoring of emerging crisis. Analysis of these factors supports arguments for a more effective early warning system in the region, especially as it affects livestock throughout the pastoral and mixed farming region of East Africa.

The emerging monitoring and analysis system, based on NIRS livestock fecal profiling technology and point-based biophysical modeling of emerging forage and animal conditions, adds a new dimension to the existing monitoring programs in East Africa. The ability to predict responses, such as impending livestock mortality by kind and class of animal, or losses in forage supply and decline in milk production, allows more flexibility in decision making from the household level to the policy maker. A more timely destocking strategy will allow pastoralists to maintain their assets through crisis. It will also aid in the assurance of ecosystem integrity by allowing more rapid response after droughts have run their cycle.

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

**Approach.** With respect to the LEWS project, warning signs refer to livestock nutritional well-being and forage imbalance

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

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

To establish empirical relationships between weather, vegetation, and regrowth potentials, soil and climate dynamics, and nutritional status and livestock productivity, tools for monitoring these components have been implemented. These same tools are also being used to establish an inventory of indicators for impending nutritional and livestock health crises. The tools include: (1) the Almanac Characterization Tools (ACT) used to assist in the characterization of the

selected zones, (2) the Nutritional Management System (NIRS/NUTBAL PRO) for monitoring feed quality from feces of the ruminant livestock, and (3) Plant Growth/Yield/Hydrology Simulation Model (PHYGROW) for monitoring grazingland herbage and crop production, respectively. A complete description of these tools can be viewed at <http://www.brc.tamus.edu/lews>.

### **Progress.**

#### **Activity One: Institutionalization Process for LEWS**

*Objective: Fully operationalize rangeland/ livestock monitoring systems in each of the LEWS regions in Kenya, Uganda, Tanzania and Ethiopia to initiate the institutionalization process in order to better support the needs of early warning, relief, and crisis mitigation agencies.*

The LEWS system was fully operationalized using the updated PHYGROW automation module with 10-d updates and can be viewed on the web (<http://cnrit.tamu.edu/aflews>) for all of the zones originally proposed: Southern Ethiopia, Northern Kenya, Southern Kenya, Northern Tanzania, Central Tanzania, and Southwest/Central Uganda. The African LEWS data on forage conditions is reaching 49 countries with over 1200 daily hits and over 2.1 GB of data downloaded on forage deviation and supply. Kenya, Tanzania, and Uganda are the largest users of the forage deviation and map data in East Africa. The use of the METEOSAT RFE data is working out very well. The weather data provided at the African Weather site that was created by LEWS (<http://cnrit.tamu.edu/rsg/rainfall/rainfall.cgi>) experienced over 24 MB of download requests to 17 countries in





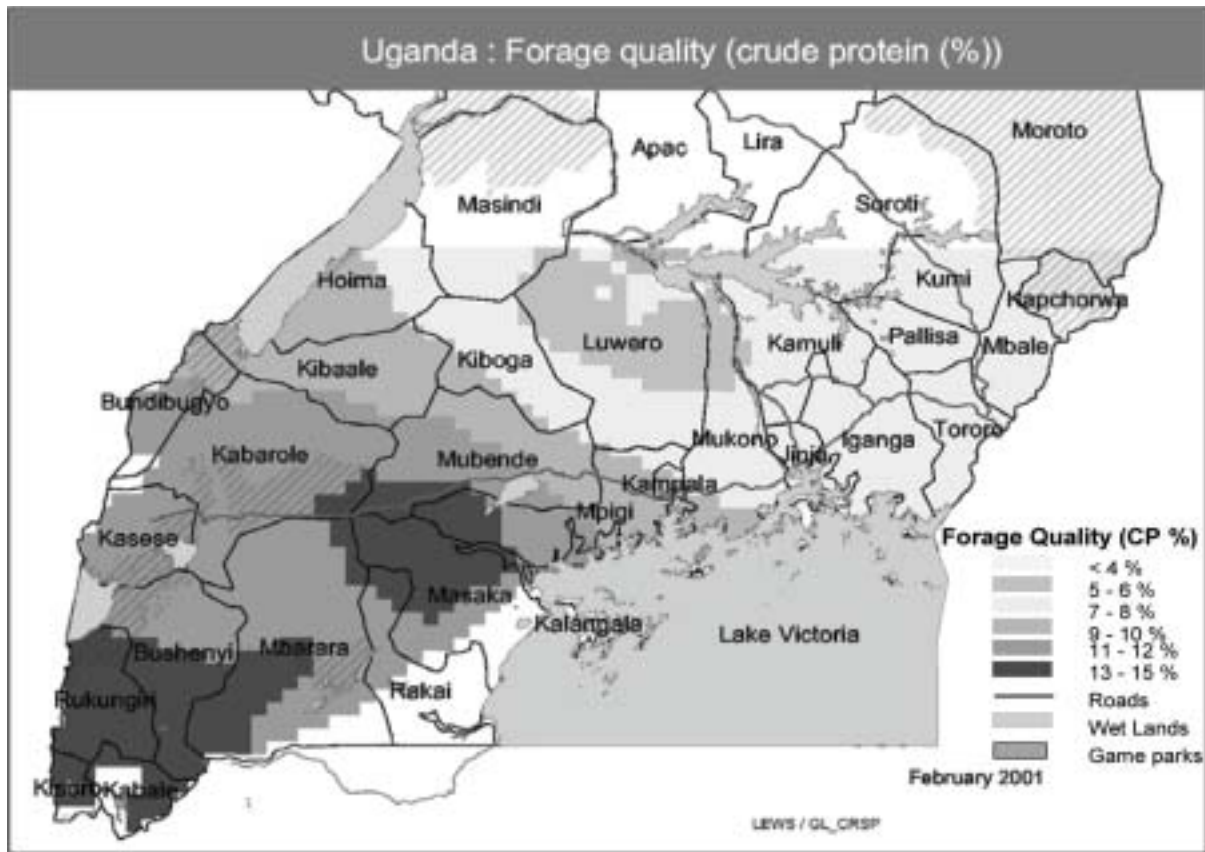


Figure 4 - Map of dietary crude protein of cattle in Southwestern Uganda (8X8 km grid resolution) using georeferenced fecal samples cokriged with NDVI greenness data.

across all generated 30 years. The 25<sup>th</sup>, 50<sup>th</sup>, and 75<sup>th</sup> percentile year was then extracted for the corresponding day of the year for a given projection date and the PHYGROW model run for each of the 250+ points. The results were encouraging, but we experienced several incidences where below normal years produced better forage conditions toward the end of the 90-day projection than above normal years due to the amount and distribution of precipitation events. To overcome this problem, we used a Fourier spectral analysis using additional denoised wavelet analysis to condition NDVI greenness data from 1980 to present to create a Box and Jenkins time series model with the denoised NDVI data co-regressed with the associated point-based model's grazed standing crop

using the ARIMA procedure in SAS. This resulted in standard errors of projected standing crop well within sampling error of our teams, out to 65 to 90 days beyond the specified reporting date. This process is fully automated at this time and is part of our distributed products.

We received funding in the last two months of the fiscal year to design and develop a prototype mapserver for all the GIS data in LEWS and to design a mechanism for other projects in GL-CRSP to upload maps for their projects as well. As of this writing, we have implemented the MAPSERVER software from University of Minnesota as recommended by EEP/GL-CRSP reviewer, Dr. Bernard Engel. The site is undergoing design and testing but appears to be robust

enough to allow delivery of all the spatial data in the project. This product will be demonstrated at the October meetings of the GL-CRSP.

LEWS/GL-CRSP was selected as one of 12 projects to be featured at the Geographic Information for Sustainable Development forum in the World Summit on Sustainable Development, Aug. 26-Sept. 4, 2002 (<http://www.opengis.org/gisd/default.htm>). LEWS was also featured in Asmara, Eritrea on April 3-6, 2002 as part of the GISD/Horn of Africa-Great Lakes-East Africa Partner Meeting along with GSDI training and policy planning for WSSD AFRICOVER regional meetings. In July 2002, LEWS spatial products were featured at the ESRI 2002 Conference as part of the GISD OpenGis forum for Africa.

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

*Objective: Establish regional analytical capacity to utilize NIRS technology for nutritional management of livestock in East Africa.*

All the NIRS labs have been put in place on schedule as per our proposed timetable in the original grant. Staffing is in place, all equipment installed, and an MOU has been signed with each institution. The Kenya lab has been expanding its capacity to private ranchers, who have requested forage tissue analysis and assistance on chicken nutrition.

A fecal solar drier was designed by engineers at Egerton University and further modified by our LEWS teams across East Africa. These devices help move drying to the location of the site monitors and cut delivery costs by eliminating the use of ice

and ice boxes. These driers have been used for forage drying as well. No significant differences were detected between oven dried and solar dried samples for crude protein and digestible organic matter as predicted by the NIRS equation implemented in Kenya.

Working with the teams in East Africa, an updated NUTBAL PRO METRIC version of the software was deployed on August 1, 2002. The following functions were improved in the system: degree of fatness adjustment to gain efficiency and intake, and correction to the fecal output algorithm for high quality diets with DOM > 64% DOM/CP ratios <4 for mature, non-lactating cows. The milk partitioning function was adjusted for East African breeds.

A fecal NIRS calibration equation for Africa was developed which allows prediction of dietary crude protein (CP) and digestible organic matter (DOM) of free ranging livestock with a high degree of accuracy. Cattle calibration was CP  $R^2=0.95$  SEP=0.87, DOM  $R^2=0.90$  SEP=2.89; Sheep calibration was CP  $R^2=0.97$  SEP=0.78, DOM  $R^2=0.94$  SEP=2.26; and Goats CP  $R^2=0.97$  SEP=0.79, DOM  $R^2=0.95$  SEP=2.86. New data from other grazinglands of the world are currently being integrated into the system to release a global calibration equation for use worldwide.

### **Activity Four: Institutional Capacity Building**

*Objective: To build technical support staff skills in use of the LEWS toolkit for active monitoring and decision making in national EWS agencies, IGAD and FEWS NET, and critical NGOs.*

To assist in development of the monthly “Greater Horn of Africa Early Warning”

newsletter produced in conjunction with FEWS NET, USGS, Regional Center for Mapping Resource Development, Drought Monitoring Center (DMC) and World Food Program, LEWS placed a more advanced computer with desktop publishing software in DMC to insure the newsletter can be produced without computer problems. LEWS/GL-CRSP provides the pastoral conditions component of the newsletter. This newsletter goes out to well over 400 key decision makers in the Greater Horn of Africa.

We were able to establish a WorldSpace radio unit and facilitate connection to the internet for the Kenya Ministry of Agriculture's office responsible for communicating warnings to and from extension personnel throughout Kenya. Our situation reports for Kenya are distributed every 10 days to all extension personnel in pastoral and agro-pastoral regions of Kenya.

We conducted training for all staff in all zones in setting up sites and conducting field verification of forage standing crop predicted by the PHYGROW model coupled to the METEOSAT RFE weather data. We currently have over 250 sites implemented in the region and 90 have been verified to date.

Working with ALIN and ASARECA CMO's Communication Officer, Rapheal Marambii, we were able to set up WorldSpace radios with data links to computers in the following locations: 5 units in the Arusha region of Northern Tanzania, 5 units in Central Tanzania, 3 units in Laikipia District of Kenya, and 5 sites in Northern Kenya. Once a day, these units allow a 15-minute download of our regional maps and analysis by ALIN and daily situation reports by RANET in .pdf format.

We also established a mechanism to produce a series of 10-day situation reports distributed via WorldSpace satellite radios on the RANET network (<http://www.meteo.go>

[ke/ranet/lews/lews.htm](http://www.meteo.go.ke/ranet/lews/lews.htm)) and Arid Lands Information Network (<http://www.alin.or.ke/data/partners.htm>). During the last year, RANET and ALIN collaborated with us and placed over 80 satellite radio information nodes in East Africa and currently mirror our website and broadcast our reports monthly in the case of RANET and decadal in terms of ALIN.

LEWS was selected as one of 12 projects in Africa as an example of "low hanging fruit" using GIS as a development tool as part of the Geographic Information for Sustainable Development (GISD) Forum at the World Summit on Sustainable Development in Johannesburg, South Africa. See page 13 of the information brochure currently distributed by USAID at ([http://www.opengis.org/gisd/docs/GISD\\_booklet\\_02\\_bf.pdf](http://www.opengis.org/gisd/docs/GISD_booklet_02_bf.pdf)).

The information flow of the LEWS reports impacted a large number (>600) of NGOs, pastoral organizations, EW agencies, and government organizations. This is provided below.

#### **Tanzania (Northern)**

Margaret Nana Kingamkono, SARI/Arusha, Female

R.N. Mero, SARI/Arusha, Male

Pillemon Mushi, SARI/Arusha, Male

Marietha Z. Owenya, SARI, Female

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R. Mtae, TLTI/Arusha, Male

G. Ngwijo, DALDO/Monduli, Male

Elias Kea, DALDO, Male

David Chalamira, DALDO, Male

Martin Halid, DALDO, Male

Reginald Swai, DALDO, Male

Enrisha Msangi, DALDO, Male

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Richard Semwenda, DALDO, Male  
Alijumaa Mkumbwa, DALDO, Male  
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Arnod Massawe, DALDO, Male  
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Dr. E.P. Osanga, DALDO/Same, Male  
Dr. Rwegasira, DALDO/Monduli,  
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B.M. Mwawado, DALDO/Karatu,  
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Dr. Tigwela, DALDO/Mbulu, Male  
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S.A. Msuya, Mwanga District, Male  
Mr. Lucas Ole Mukusi, Simanjiro District,  
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Mr. Bakari Lukuni, Same District, Male  
Mr. Gabriel Bukhay, Babati District, Male  
Mr. Leonard Ulotu, Hai District, Male  
Mr. Isaac Bayo, Mbulu District, Male  
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#### **Tanzania (Central)**

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Vitalis Temu, Livestock Research Officer,  
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Christopher Ulime, Senior Livestock Field

Officer, Male  
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Coletha Ngwando, NIRS Laboratory  
Technician, Female  
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Mwachambi, DALDO/-DODOMA, Male  
Kasanga, DALDO/KONGWA, Male  
S. Mtalo, DALDO/MANYONI, Male  
Karigo, DALDO/SINGIDA, Male  
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Manetho, DALDO/KILOSA, Male  
J.E. Mghwira, Officer In Charge/  
Mpwapwa, Male  
E.N. Pallangyo, RAA/Dodoma, Male  
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\*DALDO = District Agricultural and  
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\*RLA = Regional Livestock Adviser to  
Regional Commissioner  
\*RAA = Regional Agricultural Adviser to  
Regional Commissioner

#### **Kenya (Laikipia Zone)**

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Claus Mortensen, Mugie Ranch, Male  
Fred Lesakale, Wamba Community  
Development Program, Male  
Michael, SARDP, Male  
Abdi, SARDP, Male  
Eric, Loisaba Koija, Male  
Barnabas Ekeran, Laikipia Wildlife  
Forum/Rumuruti, Male  
Daniel Lomoe, Laikipia Wildlife Forum/

Luoniek, Male  
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Joseph Lomart, TUKASOMA, Male  
Philip Valentine, Segera Ranch, Male  
Wellington Okieno, WorldVision Kenya,  
Male

**Kenya (Southern Zone)**

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Elizabeth Nduku Muthiani, Zonal  
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Mr. Mwangi, District Livestock  
Production Officer, Male  
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Mr. Sindyo, Game Warden/Kajiado, Male  
Mr. Mbuvi, District Livestock Production  
Officer/Makueni District, Male  
Michael Kiteng'e, Divisional Extension  
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K. Mwaniki, Livestock Extension Officer/  
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J.N. Mwanjewe, District Range Officer,  
Taita/Taveta, Male  
R. Mjomba, Ranch Manager/Kasigau,  
Male

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**Kenya (Northwest Zone, Turkana District)**

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A. A. Ali, ENNDA/Isiolo, Male

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Beletu Tefera, Early Warning Dept/ DPPC, Female  
Zinash Sileshi, EARO, Female  
Getachew Haile, OARI, Male  
Dubale Adamasu, Farm Africa, Male  
Suleiman S. Mohamed, SCF-UK, Male

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Grace Ebiyau, NARO, Female  
Charles Sudhe, NARO, Male  
Everlyn Komutunga, NARO/Agrometeorology, Female  
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Mr. Majugu A.W., Department of Meteorology, Male  
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**Uganda (Central Zone)**

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Sekatte J., Site Monitor/Nabiswera, Male  
Bugeza J., Site Monitor/Lwampanga, Male

**Uganda (Southwestern Zone)**

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Kakoza U., Site Monitor/Ntusi, Male  
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Bagatuzayo W., Site Monitor/Kanyaryeru, Male  
Uitimbo J., Site Monitor/Kikaatsi, Male  
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Mr. Rusoke, ULAMP, Male

**Uganda (Karamoja)**

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Alinga Hellen, Karamoja Agro-pastoral Development Project, Female

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

*Objective: Identification of priority interventions to promote more timely livestock sales in relation to stress periods.*

We have assembled a series of GIS and spatially relevant tabular data on livestock populations/market sales updated by LEWS teams in Northern Kenya and by agencies in Ethiopia and the transborder region of Somalia. Other spatial data for both teams

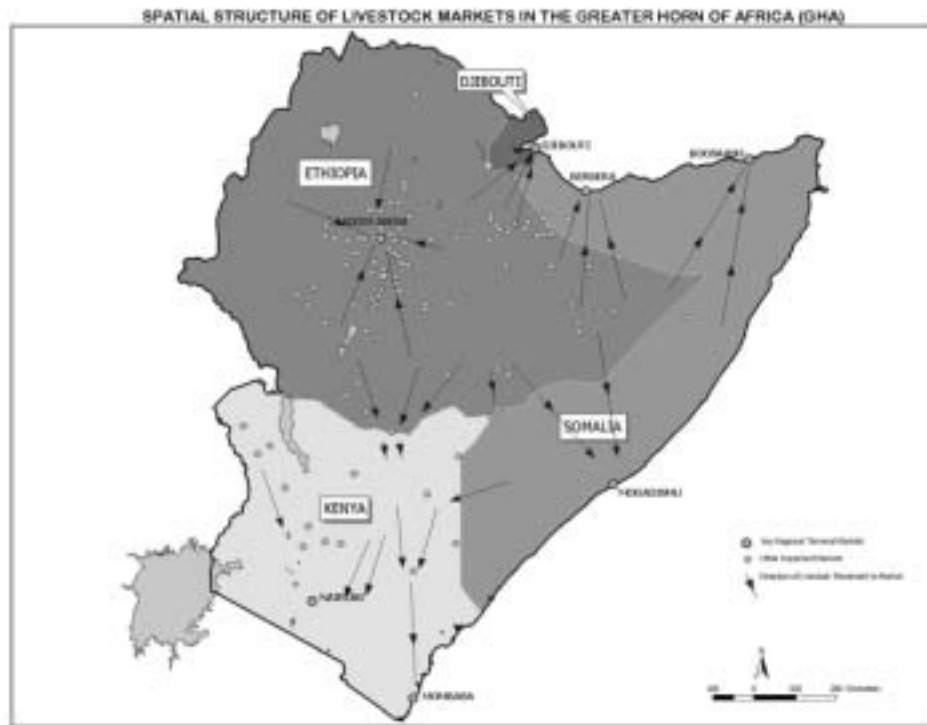


Figure 5 - Spatial structure of livestock markets in the Greater Horn of Africa

included: movement patterns, water resources, market location/prices/flow, forage resources (LEWS standing crop data back to 1998), conflict zones, disease hot spots, disease constraints, cross border trade volume/locations, export locations and volume, abattoirs, quarantine locations and loading pattern, and locating of carcass chilling plants. Most of this data has been processed into ARCVIEW/ARCINFP 8.2. The MAPSERVER software has been acquired from University of Minnesota and set up on the LEWS SunServer to accommodate all the GIS data on livestock markets as well as the array of LEWS map products. This allows LEWS and interested users to configure maps in any manner they wish to include in custom reports in the region. The basic framework of design of the spatial model has been completed with the CNRIT-LEWS programmers, and discussions with Chris Barrett and Peter Little have resulted in a consensus on how the spatial

model should incorporate decision rules emerging from PARIMA. A rule-based object oriented framework was designed and coding is currently underway with a target completion in August 2003.

## GENDER

There are two categories of women that are impacted by the LEWS project: the United States and in-country women team scientists, and in-country women within the targeted pastoral communities. This past year, we had two female graduate students and one female systems analyst working in the TAMU-LEWS project in the USA. Currently, there are seven in-country women team scientists involved in the LEWS program. Two of the female scientists are country coordinators for LEWS in Ethiopia and Tanzania. Three of the women are zone coordinators and the other two women are

site managers. The following are their specific responsibilities, by country.

**United States.** A female M.S. graduate student, Ms. Zola Gibson, is nearing completion of her MS program at TAMU with graduation in May, 2003. She verified the prediction of PHYGROW in Laikipia district and surveyed pastoral communities on perception of drought. She worked with the Mpala Research Centre (<http://www.nasm.edu/ceps/mpala>) in Central Kenya.

**Ethiopia.** Dr. Zinash Sileshi, Animal Scientist, is the in-country coordinator for Ethiopia. Dr. Sileshi has been a member of our LEWS team in Ethiopia since the beginning of the project but was promoted to a National Coordinator in 1998. She is also the Director of Livestock Research for the Ethiopian Agricultural Research Organization (EARO).

**Tanzania.** Ms. Stella Bitende is the National Coordinator of LEWS in Tanzania. She is Assistant Director - Livestock Research, Ministry of Agriculture & Co-operatives, Division of Research & Development. The position is intended to provide a focal point for consultation on technical and operational details of the relevant commodity and research for the sub-program. Ms. Bitende, in her capacity as a Lead Scientist, represents the sub-program on collaboration issues with external partners in research and development as the need arises. Margaret Kingamkono, Ministry of Agriculture in Arusha, is the LEWS Northern Tanzania coordinator.

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

the original samples and data.

Dr. Emily Twinamasiko coordinates fecal sampling activities in southwest Uganda. She is the National Research Coordinator for veterinary medicine and animal health.

DANIDA is funding a Ph.D. program at Makerere University for Ms. Rose Omaria, who is a practicing veterinarian in Uganda.

Ms. Omaria was provided intensive training funds by LEWS to come to TAMU to learn how to use the NIRS technology to develop pregnancy-testing calibrations for cattle and goats. Recent breakthroughs in pregnancy testing with NIRS at GANLab makes this a very important training event.

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

**Kenya.** Mrs. Jane Sawe, a lecturer at the Department of Animal Science, Egerton University, has joined the LEWS zonal team in Northwestern Kenya. Ms. Elizabeth Muthiani has taken over coordination of the southern Zone of LEWS in Kenya.

**Pastoralist Women.** All of our Zonal and Country Coordinators have been advised to be gender sensitive in employment for the project activities and in planning training and technology development for livestock production. This was done in recognition of the important role that women play as livestock resource managers within pastoral societies in the target. Accordingly, the LEWS program addresses itself to various types of livestock and spatial/temporal availability of feed.

Within many pastoral societies, livestock ownership and management are typically specific, with women owning/gaining income from small types of livestock and men controlling the larger ones. Engendering LEWS efforts facilitates the integration of socioeconomic concerns such as division of labor and equitable access to resources.

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

## POLICY

### *Processes of Institutionalization of LEWS in East Africa*

Based on early feedback from the ME, PAC, and EEP of the Global Livestock CRSP, the LEWS teams were challenged to design institutionalization plans for the coming years of the next funding cycle. These plans are summarized below by country. LEWS works closely with the Ethiopian Livestock Working Group (LWG). The LWA includes Ethiopian government agencies, United Nations agencies, and Non-governmental Organizations involved in livestock issues. The LWA is coordinated by FAO.

**Kenya.** In Kenya there is an extensive planning program underway to reorganize information flow from different EWS organizations in Kenya under a single, self-reliant unit called the “Early Warning and Food

Information System Unit (EW&FISU) in the Ministry of Agriculture and Rural Development (MoARD). The MoARD has submitted a TCP to FAO to help this process to go forward. LEWS representatives, including the PI of the LEWS project, have met with Mr. James Oduor, coordinator in MoARD to discuss how LEWS could best be institutionalized in the reorganization process. The Arid Lands Resource Management Project (ALRMP) is being viewed by MoARD as a good working model to integrate LEWS technology in the EW&FISU framework. Several meetings have taken place with Mr. Oduor and Mr. Maalim, National Coordinator of ALRMP in the Office of the President to discuss institutionalization of LEWS in Kenya. As of this writing, we have verbal commitment to identify key people in MoARD and ALRMP to liaison with LEWS teams and arrange training, set up networks, and establish computing capacity for the unit. The EW&FISU framework would insure that all zones are covered by LEWS technology, considering that the mandate of ALRMP would be expanded to all pastoral regions of Kenya. Other collaborating organizations in the EW&FISU would include Kenya Meteorological Department, Department of Resource Survey and Remote Sensing, Central Bureau of Statistics, Ministry of Health, FEWS NET, FAO, and Arid Lands Resource Management Project.

**Uganda.** NARO has been identified as a focal point for LEWS because of its comparative advantage. NARO is under the Ministry of Agriculture Animal Industries and Fishery (MAAIF). MAAIF is mandated to collate and collect early warning products in agriculture and pass trends and recommendations to the Ministry of Disaster Preparedness, which is mandated to coordinate

responses on anomalies in the country. LEWS has also developed reliable linkages with Makerere University (Department of Animal Science), local government through district veterinary officers, NGOs, and CBOs in pastoral areas.

**Ethiopia.** LEWS continued dialogue with the national Early Warning Department of the Drought Preparedness and Prevention Commission (DPPC) of Ethiopia. DPPC has requested LEWS to train members of their staff and allied NGOs on LEWS tools and technology. It is expected that the technology and training will move forward once the systems function has been tuned to Ethiopia's extensive conditions and EARO has been set up with a functioning NIRS fecal profiling lab.

**Tanzania.** The Ministry of Agriculture has an established crop monitoring and livestock disease-monitoring program. The livestock component is linked with OAU-IBAR. We are targeting the LEWS technology suite toward the OAU-IBAR. The national coordinator of LEWS, Stella Bitende is heading up the discussion with the Ministry of Agriculture, the Ministry of Water and Livestock Development, and OAU-IBAR representatives. Recent reorganizations of the ministries and senior officers in the ministries has created a communication gap and discussions are underway to streamline the information flow. This discussion is in its infancy and we cannot provide any more insights on progress at this point in time.

**ASARECA Crisis Mitigation Office.** GL-CRSP LEWS has invested in intensive training of an information officer and a biophysical modeling technical officer in the ASARECA Crisis Mitigation Office (CMO) located at ILRI-Nairobi (see capacity building

section). The TAMU LEWS group has been working with the CMO to help integrate the LEWS concept into the ASARECA AARNET activities. Enhancing/upgrading the information capability of the office has involved collaboration with the International Livestock Research Institute's Information Dissemination Office.

The goals of the ASARECA Crisis Mitigation Information System are:

1. To facilitate data and information flow between the LEWS teams in East Africa (NARS and universities), ASARECA-CMO and TAMU.
2. To facilitate data and information flow between the national and international institutions involved in early warning regarding weather, agriculture, and livestock.
3. To facilitate the dissemination of livestock early warning alerts from LEWS project to pastoral communities, local government leaders, and national policy makers in East Africa.

#### *Forming Linkages with FEWS-NET and Major Regional Organizations*

A partnership has formed with FEWS NET and LEWS along with the Regional Center for Mapping Resource Development (RCMRD), Drought Monitoring Center (DMC), USGS FEWS NET, World Food Programme, and Desert Locust Control Organizations to produce a monthly bulletin "Greater Horn of Africa (GHA) Food Security Bulletin." Seven bulletins have been produced as of this writing.

We also have established a working relationship in which the Disaster, Prevention, Management and Coordination Unit of the United Nations acquires our monthly reports to contribute to the Kenya Humanitarian Update.

## OUTREACH

The primary mechanism for outreach has been the establishment of a mechanism to automate and distribute 10-d and monthly situation reports to NGOs working with pastoral communities via the worldspace radio network. In Kenya we have built the capacity for the Ministry of Agriculture and Rural Development to distribute our reports to district officers over most of Kenya's rangelands. Our zonal coordinators serve as an additional mechanism to distribute reports each 10 days and monthly to their network of district officers and NGO organizations working with pastoral communities.

The LEWS Tanzania team established a booth at the National Farm Show in 2002 and was able to brief people on the LEWS program, including the Prime Minister and Minister of Agriculture. LEWS 10-day reports on Ethiopia also posted on the e-mail listserve of the Livestock Working Group, which is currently managed by FAO. The Livestock Working Group is a loose association of Ethiopian government agencies, non-governmental organizations, and United Nations agencies involved in livestock issues in Ethiopia.

## DEVELOPMENTAL IMPACT

**Agricultural Sustainability.** Timely decision making by livestock owners concerning availability of forage supply, movement, destocking, and restocking of livestock will be valuable for sustainable livestock production in East Africa. The indigenous knowledge of the pastoral societies regarding range and livestock will be much more effective if they can have access to near real-time information on impending forage shortages for livestock and location of forage

supplies that minimize conflict during periods of restrictive conditions. A combination of the indigenous knowledge and modern science can be used by decision makers to formulate clear mitigation strategies to reduce risk from weather extremes. Recent technology breakthroughs in computer modeling, weather monitoring, animal nutrition profiling, and communication infrastructures offer an unprecedented opportunity in accurately assessing impacts of emerging weather events on forage supply for livestock and wildlife and their ability to acquire nutrients to sustain themselves.

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

**Contributions to U.S. Agriculture.** The establishment of improved NIRS predictions of diet quality of livestock will have significant impact on the quality of predictions provided to ranchers throughout the USA via the national service lab at the Grazingland Animal Nutrition Lab, at Texas A&M University. Currently, this lab provides nutritional advisories to over 2,000 ranchers throughout the USA via the NIRS/NUTBAL nutritional management system. The technologies assembled and used in this project will be directly transferable to USA grazinglands. The new EQIP (Environmental Quality Improvement Program) has designated that the NIRS/NUTBAL nutritional monitoring program is eligible for incentive payments for over 35,000 livestock producers.

The USDA Risk Management Agency

(RMA) adopted the concept of the use of biophysical models to generate forage loss assessment as a basis for the new national forage loss insurance program that will affect over \$695 million in forage assets of approximately 32% of livestock producers in the USA. USDA RMA has accepted the feasibility study for this technology and is currently setting up a task order for the insurance industry to implement the system over the next four years, with a first generation system tested in 2004 followed with full implementation in 2006.

**Contributions to Host Country.** The contributions to the East African nations involved in the LEWS project include the ability to foresee and prevent, prepare for, and mitigate or resolve crisis and conflict in a more timely manner. The current set of monitoring programs offers information of initiating conditions (e.g., weather and remote sensing information) and a delayed post-effect (e.g., cattle weight and body condition loss) appraisal system. The innovative LEWS state-of-the-art contribution, based on NIRS livestock fecal profiling technology and spatially referenced modeling of emerging forage/crop conditions, will add a new dimension to the existing monitoring programs in East Africa. The LEWS addition to the current monitoring programs allows more flexibility in decision making from the household level to the policy maker by providing the ability to predict responses, such as impending livestock mortality by kind and class of animal and losses in forage supply and decline in milk production. Thus more timely destocking strategies will allow pastoralists to maintain their assets through crisis and assure greater ecosystem integrity to respond more rapidly after droughts run their cycle.

Also, during this past year, the LEWS

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

1. Improved collaborative approach and regional outlook on livestock issues among LEWS host countries. An awareness that most of the problems related to livestock production and development are cross-border problems; and
2. Improved shared understanding and recognition of the importance of livestock in early warning systems. As is evident from the national agricultural early systems currently in place, the livestock sector in all of the host countries is either ignored or marginally covered. The policy makers of various livestock ministries in East Africa have intimated that they are looking to the LEWS project to remedy this situation. There seems to be an improved collaborative approach and shared understanding of their livestock systems.

The national outreach specialists of ministries and NGOs were provided training in the use of the various biophysical models and the spatial analysis tools employed for this project. The goal is to enable the national institutions and their staff to become proficient in the use and application of these tools. Other educational and technical contributions include graduate training for some of the

national scientist and technicians trained to use the instrumentation, and various workshops designed to establish monitoring routes and protocols. Other equipment (e.g., GPS units, computers, software, etc.) has been provided to the in-country team leaders and zone coordinators.

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

In Ethiopia, we intensified our working relationships with DPPC and Save the Children-UK.

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

**Collaboration with International Research Centers (IARCS) and other CRSPs.** The primary IARC collaborators are scientists at the International Livestock Research Institute located in Nairobi, Kenya and Debre Zeit, Ethiopia. The first NIRS laboratory was established at ILRI-Debre Zeit. We also assisted ASARECA at ILRI-Nairobi to establish a Crisis Mitigation Office, integrated with the LEWS reporting system as a primary link to NGOs, regional organizations, national policy makers, and

international early warning and relief organizations. ILRI has collaborated with LEWS on a SPAN grant with USAID, focusing on capacity building for use of biophysical models.

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

#### OTHER CONTRIBUTIONS

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

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

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

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

**Humanitarian Assistance.** The need for humanitarian assistance usually emanates from poverty-related degradation of natural resources. An early warning system for livestock is essential both for food security by protecting the natural resource base and disaster preparedness. A proactive early warning system will help in making people in the region less vulnerable to disasters by alerting them of impending crisis and provoking a humanitarian assistance response from local and international relief systems (e.g., governments, donor, and NGOs).

## LEVERAGED FUNDS AND LINKED PROJECTS

The LEWS subproject has been able to leverage funds and personnel from multiple sources to ensure that the program is moving forward and up-to-date technologies are being used in the project. A total of \$694,150 was funded within the group this year alone, not counting the normal cost share funds of TAES salaries noted in the grant budget for 2000-01. Specific grants and funding levels are as follows:

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

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

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

*USDA-NRCS - \$25,000* - "Development of livestock early warning outreach programs." Design protocols for effective communications

with ranchers as it relates to the Texas Livestock Early Warning System.

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

*USDA-NRCS - \$160,000* - "National Nutritional Well-being Program for USA using the NIRS/NUTBAL PRO Nutritional Management System." This is the 4th year of funding. All technology generated in this program is deployed in LEWS. Funded to Dr. Stuth.

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

#### TRAINING

##### *In Progress:*

Stephen Byenkya, PhD student, Dec. 2003, Range Science, Texas A&M University.

William Mnene, PhD student, Dec. 2003, Range Science, University of Nairobi.

Peter N. Kamau, PhD student, Dec. 2003, Range Science, Egerton University

Negusse Kadine, PhD student, Dec. 2004, Range Science, Texas A&M University.

Rose Omaria, PhD student, Jan. 2004, Animal Science, Makerere University.

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

Kosi Awuma, PhD student, Aug. 2003, Range Science, Texas A&M University.

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

Laban Macopiyo, PhD student, Dec. 2004, Range Science, Texas A&M University.

##### *Completed:*

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

Sarah Ossiya, PhD, Aug. 1999, Range Science, Texas A&M University.

Mohammad Hamid, PhD, Aug. 2002, Range Science, Texas A&M University.

##### *Short term: Workshops, Short Courses*

NIRS Calibration Training provided to Constantine Shiryo and Rose Omaria at Texas A&M University via funding from FAO and DANIDA, respectively. Mr. Shiryo is the lab director for the NIRS lab in Dar es Salaam, Tanzania. Ms. Omaria is working on her Ph.D.

Workshop on Livestock Early Warning Systems conducted May, 2002 in Addis Ababa, Ethiopia and funded by FAO. Approximately 60 participants attended and a proceedings was produced.

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**PUBLICATIONS**

Issued 7 Greater Horn of Africa Early  
Warning Bulletins, produced jointly with  
FEWS NET, USGS, DMC, UNEP, and KMO.

Issued 10 monthly Situation Reports each  
for Kenya, Uganda, Ethiopia, and Tanzania via  
RANET, ALIN, and LEWS coordinators that  
reaches worldspace satellite radios across the  
zone.

Issued 36 dekadal maps and situational reports over the web (<http://cnrit.tamu.edu/aflews>), with 2.1 GB of data download to 49 countries.

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Ethiopia.

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Africa. Proceedings of the Planning and Evaluation Workshop, Ethiopian Agricultural Research Organization. May 5 – 7, 2002, Addis Ababa, Ethiopia.

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The entire team of LEWS zonal coordinators made presentations at an FAO sponsored conference on Livestock Early Warning Systems for East Africa. Proceedings of the Planning and Evaluation Workshop, Ethiopian Agricultural Research Organization. May 5 – 7, 2002, Addis Ababa, Ethiopia. (see papers listed in previous section).

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## IMPROVING PASTORAL RISK MANAGEMENT ON EAST AFRICAN RANGELANDS

### NARRATIVE SUMMARY

This was the fifth year of work for the pastoral risk management (PARIMA) project. The overall goal of our project is the discovery and application of knowledge pertaining to improving risk management—and thus enhancing livelihoods—for pastoral and agro-pastoral people in northern Kenya and southern Ethiopia. Foundation concepts include the exploration of opportunities to better diversify incomes and assets and how to improve the use and delivery of information and various public services. The year is best characterized by the following achievements: (1) a quarterly repeated survey for 11 communities throughout our study area over two years was successfully completed; (2) research projects for nine graduate students—including Kenyan, Ethiopian, and American nationals—are either virtually completed or well underway; (3) 31 research and outreach publications were produced for technical and popular audiences, with another eight manuscripts in the process of final revision and submission; (4) over 100 people participated in workshops, a short-course, and educational tours intended to strengthen linkages and transfer information among researchers, pastoralists, traders, and local decision makers from southern Ethiopia and northern Kenya; (5) five community-based pilot intervention projects involving hundreds of beneficiaries are underway in southern Ethiopia; and (6) the PARIMA project received a favorable review from the External Evaluation Panel (EEP)

representing USAID Global Bureau. We have remained true to our original problem model. Workplans and outputs in Year 5 are almost exactly on track with what we outlined in the original project proposal. Team members have been very productive and creative with resources provided by the GL-CRSP.

### RESEARCH

**Activity 1: Research on Risk at the Individual, Household, and Community Level, led by Drs. Christopher Barrett, Peter Little, and John McPeak with participation from Drs. Getachew Gebru, Cheryl Doss, and other team members.**

**Problem Statement and Approach.** One of the core issues investigated by the PARIMA project is the extent to which pastoralists share a common perception and experience of risk. The common assumption is that most risk experiences are common to most pastoralists. This assumption has important implications for the way that interventions are structured. When risk is broadly shared across a population, external resources are essential to enable recovery from shocks and rural financial, marketing, and social insurance systems are prone to failure. When the risk experience is highly variable (idiosyncratic) within a population, local systems have greater capacity to manage risk internally so long as a basic physical and institutional infrastructure

is in place. So one of the project's first research activities has been to explore intra-regional variability in risk exposure and risk perceptions. Two different research efforts have contributed to this activity. We started with a participatory risk-mapping activity documented in GL-CRSP Annual Reports for 1999 and 2000. This was followed by a more detailed, repeated survey implemented for 330 households in 11 communities (six in Kenya and five in Ethiopia) using a cluster sampling approach. Five of these communities are Boran, with one each from the Rendille, Ariaal, Il Chamus, Gabra, Samburu, and Guji. The survey was launched during March 2000 and was intended to be repeated on a quarterly basis over the next two years. Survey work has been devoted to: (1) delineating sources of risk affecting individuals, households, and communities; (2) understanding the effectiveness of various indigenous tactics for reducing risk exposure such as livestock accumulation, livestock mobility, and social insurance systems; and (3) understanding the effectiveness of various introduced tactics for reducing risk exposure such as livestock marketing, access to rural financial networks, economic diversification, and use of relief as well as other forms of external assistance. Communities have been stratified and purposely chosen so as to capture important differences in agro-ecology, access to towns and infrastructure, and ethnicity. Individual-level surveys have not only been fielded to household heads, but also to randomly selected junior male and female adults from each household in order to illuminate gender and generation differences that condition risk exposure and response. The survey instruments capture information on household structure, asset holdings, activities, consumption, mobility, livestock transactions, experience with raiding, risk assessments, past

risk exposure, etc. Effort has been made to capture actual behaviors as well as risk perceptions.

**Progress.** The quarterly repeated survey was completed in June 2002, with data processing occurring through September. In this progress report we add detail and new insights pertaining to previously reported findings. We have tracked the 330 households beginning at the end of a drought phase in 2000 through two subsequent years of herd recovery. In general, we have observed that livestock accumulation in anticipation of calamity is an effective but costly means of promoting a viable future herd size. It is costly because, in general, for every six animals that entered the last drought in the late 1990s, one survives. Despite such losses, overall it appears that the higher the livestock number going into a drought, the higher the number coming out. This form of self-insurance seems rational in light of a lack of alternative investments. Few pastoralists use formal savings accounts, and alternative business ventures are scarce. Opportunities for income diversification appear to be limited to the proximity of urban settlements. We have also noted that communities can vary in terms of the degree that drought impacts their livestock. Local variation appears to be related, at least in part, to differences in resource endowments and livestock mobility. Communities in Kenya that are hemmed in by neighboring ethnic groups—or otherwise lacking access to a diversity of watering and grazing areas—appeared to lose the highest proportions of stock. Within communities households can vary with respect to drought-related livestock losses. While local access to resources may play a role, we suspect that differences imparted by wealth are important. Very large herds held by the wealthiest pastoralists in

Ethiopia can actually experience high rates of losses, and we suspect that the ability to secure resources and effectively manage larger numbers of stock contributes to this observation. At the other end of the spectrum, the small herds of the poorest pastoralists may also suffer disproportionate losses. High rates of milk off-take to support people from fewer lactating animals per capita, and inability to purchase livestock health inputs, may play a role in this phenomenon. These observations contribute to the notion that while some degree of drought-related asset loss is covariate—or widely shared—among pastoral households and communities, there is a substantial degree of idiosyncratic variation that is related to attributes of individual communities and households. Ineffective indigenous reciprocity networks, noted in the GL-CRSP Annual Report 2001, contribute to the general problem of a lack of social safety nets. The ranks of the peri-urban poor swell because once a household's herds dip below a dozen animals, the prospects for recovery are slim. Such households may slide into a "poverty trap" and thereafter be confined to a precarious existence involved in petty trade or small-scale cultivation in the vicinity of towns and villages. The lure of food aid probably contributes to this issue of sedentarization. Throughout our Kenya sites food aid is the most ubiquitous form of public service in our area.

Our survey work suggests two forms of intervention have some effect on mitigating effects of drought on livestock management and household welfare: market infrastructure and formal education. As noted in the 2001 GL-CRSP Annual Report, those pastoral households in our study area fortunate enough to have access to a livestock market served by an all-weather road were able to sell more stock in response to a drought shock—and buy

more animals for restocking—compared to those households with the typical lack of access to such opportunities. Although returns to formal education are anticipated to be variable over space and time, preliminary evidence from some study sites in northern Kenya indicates that households with educated members are able to reduce risk of income variability due to drought. This is because educated family members are more likely to find wage employment and provide remittances back home. Variability in rates of school enrollment for northern Kenya varied from 15% (North Horr) to 90% (Ngambo). In general, the more remote the study site, the lower the rate of school enrollment. Variability in total income over a sample three-month period for the Kenya sites also varies widely. Values range from KSh 2,200 per household (North Horr) to KSh 5,200 per household (Ngambo) and KSh 9,500 per household (Logologo). Increased total income is associated with increases in non-pastoral income, and this illustrates the role of non-pastoral activity diversification for boosting income where employment opportunities occur. Although the Ethiopia data have yet to be analyzed to the same degree as the Kenya data, the Ethiopian situation is generally much less favorable than the Kenyan situation. Enrollment in formal education is uniformly very low in Ethiopia (<5%) and evidence for non-pastoral income diversification is very limited compared to Kenya.

As noted in the GL-CRSP Annual Report 2001, these findings point to the idea that technical interventions and policies should attempt to support—not undermine—the traditional means for pastoralists to manage risk. These include efforts to promote herd mobility, livestock accumulation especially for mid-sized holdings, and providing the means for opportunistic marketing. Investment in

security should help reduce risks associated with access to key resources and hence favor some restoration of herd mobility. Investment in primary education is important because it can help give people the skills to augment pastoral livelihoods with salaried incomes. Investment in marketing infrastructure and institutions is important, and particularly so for populations residing in remote locations with poor market access. The potential for sustainable financial systems needs to be re-evaluated once market activity and income opportunities expand. Finally, one could promote investment in non-pastoral economic activities to widen the range of desirable employment and investment opportunities. This would especially be useful for providing income-generating opportunities for the peri-urban poor.

In summary, we are very pleased with the quarterly repeated survey. Results are consistent in many respects with our expectations and have reinforced our confidence in our original problem model. We have two years of solid data that will generate possibly dozens of important publications. We have only touched on a small part of the work here. Further elaboration must wait for a very large effort in data analysis and interpretation to be completed. We hope, in a subsequent project phase, to continue the survey on an annual basis. This would allow us to capture the dynamics related to the entire drought recovery cycle. The next regional livestock crash is anticipated to occur no earlier than 2005.

**Activity 2: Thematic Investigations  
Dealing with Marketing, Rural Finance,  
Natural Resource Management,  
Indigenous Use of Climate Forecasts,  
Social Change, Natural Resource Tenure  
and Conflict, and the Origin and Fate of**

**Pastoral Refugees, led by Drs. Chris Barrett, Peter Little, Abdillahi Aboud, John McPeak, Getachew Gebru, and Cheryl Doss with participation by other team members.**

**Problem Statement and Approach.** The regional perspective of pastoral risk management as generated from the repeated quarterly survey is being supplemented with local case studies. Such work is particularly appropriate as training projects for graduate students. Each case study has a unique character that reflects local issues as well as priority interests of students and their supervisors. Work carried out in Year 5 variously examined risk as related to enabling systems, production system change, conflict, coping strategies, and resource tenure dynamics. Approaches are generally based on survey methods.

**Progress.** This activity encompasses the work of nine graduate students that are listed in the degree-training section below. The breakdown of the students by nationality is six Kenyans, two Ethiopians, and one American. Six are master's students and three are doctoral candidates. Progress for each project is noted below:

Mr. Moses Esilaba, a Kenyan seeking an MS degree from Egerton, has studied conflict resolution among the Samburu. Some of his work was noted in the GL-CRSP Annual Report 1999. He ended the year awaiting the final corrections on his thesis.

Mr. Clement Lenachuru, a Kenyan seeking an MS degree from Egerton, has studied the influence of formal education on economic diversification among the Il Chamus. Some of his work was noted in the GL-CRSP Annual Report 1999. He ended the year awaiting the final corrections on his thesis.

Mr. John Tanguis, a Kenyan seeking an MS degree from Egerton, has studied the influence of economic diversification on risk management among the Samburu. Some of his work was noted in the GL-CRSP Annual Report 1999. He ended the year awaiting the final corrections on his thesis.

Mr. Waktole Tiki Uma, an Ethiopian seeking an MS degree from Egerton, has studied the influence of traditional leadership among the Boran on natural resource management. His final results have recently been drafted and are not ready to report here. He ended the year having submitted his draft thesis to his supervisory committee. His work will be described in future GL-CRSP Annual Reports.

Mr. Godfrey Nato, a Kenyan seeking an MS degree from Egerton, has studied Turkana refugees in peri-urban conditions in Baringo, Kenya. Nato wanted to learn how they became refugees and how they have coped with refugee life—in some cases for many years. He recently completed his field data collection and ended the year writing his draft thesis. No results are available for reporting at this time. His work will be described in future GL-CRSP Annual Reports.

Mr. Abdullahi Dima Jillo, a Kenyan seeking a PhD degree from Egerton, has studied natural resource tenure and conflict among the Boran in northern Kenya. He has spent the past year involved in data collection. No results are available for reporting at this time. His work will be described in future GL-CRSP Annual Reports.

Ms. Sharon Osterloh, an American seeking an M.S. degree from Cornell, has studied the performance of rural financial associations in northern Kenya. Her work was reported extensively in the GL-CRSP Annual Report 2001. She is currently finalizing her thesis in the USA.

Mr. Hussein Mahmoud, a Kenyan seeking a PhD degree from the University of Kentucky, has studied the attributes of livestock trader networks in northern Kenya and southern Ethiopia. His work was reported extensively in the GL-CRSP Annual Report 2001. He is currently writing his dissertation in the USA.

Mr. Amare Teklu, an Ethiopian seeking a PhD from Cornell, has studied land use change among the Ethiopian Boran. He is currently back in the USA and is analyzing his data. His work will be described in future GL-CRSP Annual Reports.

Our progress has been excellent in this activity. It is merely a coincidence that new results are not ready for this particular Annual Report due to student schedules. Work from these projects has not led us to alter our original problem model, which we feel is on track.

### **Activity 3: Collaboration between PARIMA and LEWS, led by Drs. Chris Barrett, Jerry Stuth, and Peter Little.**

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

more favorable pre-drought prices, reduce drought-related mortality losses, and relieve pressure on natural resources. Other tools to aid this decision-making process include models that predict forage production as a result of precipitation and those that predict livestock nutritional status as a function of the quantity and quality of forage. Given insights into anticipated patterns of forage yield and livestock production, pastoralists and traders could be further compelled to engage in pre-emptive de-stocking and other related adjustments. Work of the PARIMA project complements these objectives in several respects. First, the PARIMA project is interested in the actual factors that influence how pastoralists make decisions to sell animals. For example, favorable prices may be a key determinant, as could the need to buy non-pastoral food. Conversely, if pastoralists have few alternatives to storing wealth as livestock, it is rational for them to hold all of their animals and hope that providence spares them and they will survive a drought unscathed. This logical traditional rationale may be becoming harder to justify as fallback resources dwindle, human populations increase, and local resource degradation intensifies. In addition, if market infrastructure is lacking, there may not be opportunities for many pastoralists to sell stock in anticipation of drought even if they wanted to (see Activity 1).

Work by PARIMA scientists reported in the GL-CRSP Annual Report 2001 indicates that assumptions about the demand for information among pastoralists by the research and development community may be erroneous in some respects. For example, some pastoralists in Kenya have access to official drought forecasts via radio or newspaper reports, but it appears that they would rather rely on indigenous means to predict rainfall. They tend to use eyewitness scouting reports

to gauge forage conditions and the opportunities for moving animals to evade unfavorable circumstances. This suggests that official early warning broadcasts may have many obstacles that would impede their utility for pastoral people.

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

**Progress.** PARIMA has launched household-level surveys on decision-making as it pertains to livestock sales across the 330 households at our 11 study sites. In addition, PARIMA has conducted market-level surveys in northern Kenya at Marsabit, Marigat, North

Horr, and Suguta Mar Mar to provide data on livestock price and features of livestock supply in these locations. A similar market-level survey has been prepared for Ethiopia before the end of Year 5 and it will be launched early in Year 6. The LEWS project has taken the lead in mapping our households with respect to agro-ecological zone and proximity to markets using geo-referenced data. Both survey and mapping components are on going. We have made good progress in this activity. Data are being processed and preliminary results are not available for this report.

**Activity 4: Project Regionalization, led by Drs. Layne Coppock and Solomon Desta.**

**Problem Statement and Approach.**

From its inception, the PARIMA project has focused on a study area in northern Kenya and southern Ethiopia. Although research findings from this large and diverse area are applicable to a wide range of similar situations in the Greater Horn of Africa, it is desirable to extend the influence of the project more broadly. The main objective of this activity is thus to disseminate PARIMA research, outreach, and training concepts more widely in East Africa. The mechanisms for doing this are diverse. One means has involved PARIMA Biennial Workshops, held in Addis Ababa (1999) and Njoro (2001). These meetings in total attracted over 160 participants, with at least a dozen representing East African countries other than Ethiopia and Kenya. A second means has involved the dissemination of information via electronic and hard copy options, both for formal research publications, GL-CRSP research briefs, and the PARIMA UPDATE Newsletter. This occurs through our network of some 50 research and development organizations and on a request basis. The third and most intensive approach involves linking

PARIMA to research institutes through formal agreements elsewhere in East Africa. One motive for the Second Biennial Workshop at Njoro in 2001 was to establish links to scientists in Uganda and Tanzania. Representatives from Uganda [Dr. Sarah Ossiya of the Serere Research Institute (SRI) near Kampala] and Tanzania [Mr. Ezekiel Goromella of the Livestock Production Research Institute (LPRI) in Mpwapwa] gave overview papers of how risk management themes developed on PARIMA pertained to the work of their institutions. Indeed, the PARIMA themes were very relevant. The idea was to then provide small grants to Ossiya and Goromella to initiate community-based, action research initiatives along the lines of the PARIMA Outreach and Action Research in southern Ethiopia, founded on Participatory Rural Appraisal (PRA). This is outlined under Activity 5 below.

**Progress.** Because this report concerns an alternate year where no Biennial Workshop was held, no progress was made in terms of convening research and development professionals per se. A Third Biennial Workshop is planned for 2003, however, and that approach will continue then. In terms of information dissemination, we have been successful in distributing hundreds of copies of research papers, research briefs, and newsletters. In terms of institutional linkages with Uganda and Tanzania, the activity has stalled. This is primarily because a re-assessment of funding has convinced us that unless we are able to secure leveraged resources, we are unable to offer firm and sustainable interactions elsewhere. The Ugandan connection has also suffered due to a reassignment of Dr. Ossiya to a new job unrelated to her former employment. For the future our main plan is to continue to upgrade

and expand information dissemination via electronic means through the ASARECA network. We feel that this approach is most consistent and sustainable with respect to our capabilities and resource constraints.

**Activity 5: Action Research in Support of Pilot Risk Management Interventions in Ethiopia, led by Drs. Solomon Desta, Layne Coppock, and Getachew Gebru with Participation from Local Development Partners and Personnel from the Southern Tier Initiative of the USAID Mission to Ethiopia.**

**Problem Statement and Approach.** In the GL-CRSP Annual Report 2000, the Outreach Unit of the PARIMA project was described. The overall goal of the Outreach Unit is to increase awareness and build capacity among project beneficiaries, development partners, and policy makers for the effective implementation of risk management interventions. This involves traditional activities such as hosting workshops, organizing short courses and field tours, and disseminating research and extension publications. PARIMA Outreach serves a multi-purpose catalytic role in southern Ethiopia and the northern Kenya borderlands as a facilitator, donor, educator, and research agent. See the sections on Outreach, Non-Degree Training, and Gender elsewhere in this Annual Report for details on these and related activities. Outreach operating costs are covered by the USAID Mission to Ethiopia.

One non-traditional component of PARIMA Outreach has been an “action research” function. This occurs when PARIMA works with local research and development partners in monitoring outcomes from pilot risk-management interventions

among pastoral communities and various forms of cross-border interaction. Action research involves a rapid analysis of step-wise constraints encountered after pilot interventions have been implemented. Remedial efforts are then recommended to overcome constraints and help make interventions successful. Funds to support pilot interventions have been provided under the auspices of the Southern Tier Initiative (STI) of the USAID Mission to Ethiopia. As described in the GL-CRSP Annual Report 2001, pastoral communities volunteer to be engaged in a process of Participatory Rural Appraisal (PRA) with a local development agent (GO or NGO). The PARIMA Outreach Unit oversees the process that leads from the PRA to production of a co-authored Community Action Plan (CAP) between the community and the development agent. The CAP is submitted to a 10-member Outreach Review Panel (ORP) for review and modification. If approved, the CAP is funded by PARIMA using resources provided by the USAID Mission to Ethiopia. Then PARIMA partners with the development agent to monitor the initiative and observe where things go right or wrong. The product is a situation where everyone should benefit. The community is empowered to initiate change, development agents are trained in PRA and monitoring, and PARIMA documents outcomes as applied research contributions. In addition, the PARIMA project has a strong interest in discovering innovative, indigenous risk-management behaviors within our study area, and where appropriate, sharing such findings with local communities and their development agents and then monitoring outcomes accordingly.

**Progress.** As reported in the GL-CRSP Annual Report 2001, the ORP received eight

CAP proposals for funding consideration. These came from communities in the vicinity of the towns of Yabelo, Negelle, and Moyale. All CAPs were based on a full or partial PRA conducted by development agents recently trained by the Egerton University PRA team and that also have participated in the PARIMA Outreach Network since 1998. Most of the CAPs were modified and approved for funding. Here we report on an example of preliminary outcomes for some CAPs approved during 2001.

Two CAPs involve the Dida Hara community, a group of semi-settled pastoralists located about 50-km southeast of Yabello town. The development partner is Action for Development (AFD), an Ethiopian NGO based in Yabello. A full PRA revealed that the people wanted some means to improve their income through small-scale economic diversification. Given high rates of illiteracy (>90%) and no means to facilitate access to savings and credit opportunities, the PRA process revealed that possible solutions would be found in improved access to education and rural finance. The CAP thus advocated establishing non-formal education centers and savings-led credit associations. A non-formal rural education center was initiated to ultimately serve 660 men, women, and children. Two centers were built in the sub-communities of Dembi and Harawatu. Five savings and credit associations were established for 175 pastoralists (57% women). The general design of interventions followed AFD protocols. A monitoring system was set up by PARIMA in collaboration with AFD. Male and female community leaders in Dida Hara were subsequently selected to participate in short courses offered by the Furra Institute (see Non-Degree Training). Female leaders were selected to participate in a cross-border tour to visit successful women's groups in northern Kenya (discussed below).

In terms of non-formal education, an average of 38 children and 53 adults have been enrolled per quarter over the past year at the two centers. Significant progress has been made, particularly in basic numeracy. In terms of rural finance, as of September 2002, the five savings and credit groups at Dida Hara have saved about Ethiopian Birr 25,000 (or USD 3,125.00). Records of savings are kept in individual passbooks that the people are now capable of keeping records in because of their participation in the non-formal education activity. Ninety participants (46% of them women) received six-month loans averaging Ethiopian Birr (or USD 82.50). People eligible to receive loans were those that had been successful in achieving a savings target. Given the early stages of the program, loans were also augmented with additional funds from AFD coffers to increase the base capital and spur incentives for beneficiaries to be responsible participants. The first six-month loaning period ended in August. Loan repayment was 100% with five percent interest. Seventeen recipients used their loan for investment in petty trade. The other 73 used their loan to purchase a bovine or small ruminant to grow out and sell. A second group of 85 received their six-month loan in September. Performance of pilot projects at Dida Hara and other locations continues on a quarterly basis.

Successful women's groups were discovered in northern Kenya by PARIMA in 1999 during routine outreach surveys. Perhaps dozens of such groups exist. A Boran women's group at Kulamawe (near Isiolo) appears typical of successful innovators. Formed over 15 years ago, the initial membership of the Kulamawe group was comprised of destitute, illiterate women. Group leaders formulated a development plan based on a system of regular, pooled savings. Once certain amounts of

money were saved, the group then began to invest in improving their homes, starting small business ventures, and sending their children to school. Capital accumulated over time and now the group at Kulamawe manages a significant array of small enterprises. The group provides financial support for local schools, infrastructure, and health care. Similar groups have been contacted in Sololo, Badahuri, Gerbi, and Kalicha. These groups are typically Boran. The groups are also engaged in helping other women organize themselves into sustainable development groups. After reviewing this situation, we decided to put Ethiopian pastoral women in contact with the Kenyans and observe what happens.

The fifteen Ethiopian women selected for the Kenya tour had emerged as natural leaders in their respective communities of Dida Hara, Negelle, and Moyale. Of these 15, only one had had any previous experience with community group formation, that being an affiliation with an OADB-sponsored smallholder dairy cooperative. The 15 women thus were chosen to strategically represent three sub-locations on the Borana Plateau. Each sub-location had submitted CAPs that were approved for funding by the ORP, and these women were seen as innovators and leaders in the context of these projects as well. None of the 15 women had been out of their sub-locations previously, let alone traveled outside of the country. The Ethiopian women appeared to be fundamentally transformed by the visit with the Kenyan women's groups. They were impressed with the vision, independence, and drive of the Kenyans. The tour appeared to give the Ethiopian women hope and determination to succeed in lifting themselves out of poverty.

The result of this simple tour has been extraordinary in the past year. Roughly 16

women's groups have been formed in southern Ethiopia during the past nine months, with nearly 450 members. Demand for group formation is now pervasive. The groups model their activities after what they saw in Kenya. Typically, a group erects a meeting center. Efforts to improve their living standards include purchase of mattresses, mudding of walls, improvements in personal hygiene, and increased enrollment of children in schools. Savings clubs are at the core of the activities. In the vast majority of cases, the men are supportive of the women's new activities. Groups are being monitored quarterly.

This process of documenting induced change is research. It informs us as to what risk management interventions are feasible and lets communities and individuals better control their destiny. Some preliminary observations include the following: (1) engaging communities in a true participatory development framework unleashes tremendous energy for positive change; (2) there is evidence of indigenous solutions for poverty mitigation; (3) risk management—focused on education, diversification, and sharing of information—is a prominent spectrum of priority interventions; (4) women and women's organizations—even among pastoralists—can offer major opportunities and entry points for positive change; and (5) national borders can be relatively impermeable to the simple transfer of information and experiences, even within the same ethnic group.

## GENDER

Gender dimensions of the PARIMA project are reflected in terms of: (1) how our team is organized; (2) research questions and issues being pursued; (3) how training benefits are allocated; and (4) types of people

participating in our outreach. For example, we have one female scientist on our core team, Dr. Cheryl Doss of Yale University. She is an economist. We are studying how risk affects female pastoralists differently from males (see Activity 1). It is well known that perturbations in our study region often result in female-headed households being re-established nearer to towns and settlements. These are often the poorest households with few assets. These female heads of households are often forced to diversify their income-generating activities to survive. These women are a major focus of our research and outreach efforts. We have given various forms of support to female trainees in our project. For degree training, we supported a Kenyan woman named Winnie Luseno in her doctoral program at Cornell. An American woman named Sharon Osterloh, also at Cornell, was supported as she began to write-up her master's thesis. For non-degree training we have focused a large component of our outreach on women's groups (see Activity 5 and the Training section that follows). In our outreach network we have included roughly 52 organizations, with 25 in Ethiopia and 27 in Kenya. Senior women represent nine of these organizations. We initiated a 10-member Outreach Review Panel (ORP) in 1999 that helps guide outreach. There are currently nine members (pending replacement of one member who has retired), and one third of the ORP members are currently senior women. These include Ms. Miriam Cherogony, a Kenyan specialist in rural finance, Ms. Felekech Lemecha, an official with the Oromia Agricultural Research Institute in Ethiopia, and Ms. Allyce Kureiya, a Kenyan pastoral development specialist working with an NGO in Isiolo.

## POLICY

We have two main goals regarding policy. The first is to build a general awareness of our existence among key policy makers and institutions. The second is to engage key policy makers in project activities. To achieve the first goal we have continued to widely distribute copies of project publications, including technical papers, research briefs, and the PARIMA UPDATE Newsletter. To achieve the second goal we have invited key individuals to workshops, field tours, and training opportunities—and they have responded. Policy makers have attended our workshops and given presentations, and have even participated in short-courses. A one-week field tour was sponsored by PARIMA in southern Ethiopia during August 2002 and some 10 key Ethiopian policy makers in the Oromia State participated. Our challenge remains to better involve Kenyan policy makers. Overall, we feel this process of gradual engagement of policy makers with the PARIMA project is working well.

## OUTREACH

The Outreach Unit of the PARIMA project has been previously introduced in the GL-CRSP Annual Reports for 2000 and 2001. Operating funds for outreach are provided by the USAID Mission to Ethiopia. Current outreach activities under the banner of action research have been mentioned under Activity 5 in this report. The objectives of PARIMA Outreach are to build awareness and capacity of front-line development personnel and pastoral communities to conceive and adopt risk-management interventions and to identify some best-bet approaches to improve pastoral risk management based on results from pilot interventions. Achievements during Year 5

prominently include: (1) distribution of PARIMA publications within the region, including over 1,000 copies of the first issue of the project newsletter PARIMA UPDATE in English, Kiswahili, and Oromifa; (2) successful initial networking of Boran women's groups from Ethiopia and Kenya (see sections on Publications, Training, and Gender); and (3) successful initiation of five community-based pilot intervention projects among Boran pastoralists at Dida Hara, Negelle, and Moyale in the southern Ethiopian rangelands. The PARIMA Outreach Unit in Ethiopia largely functions as a facilitator and catalyst for positive change. The community pilot projects are dominated by requests to establish rural savings and credit associations to facilitate small-scale economic diversification. Another major intervention is the creation of non-formal education centers for children and adults. Pilot projects are conceived and designed by communities through a process of interactive community needs assessment such as Participatory Rural Appraisal (PRA). Community leaders of the five pilot projects include men and women. Pilot projects are implemented by communities and local GO and NGO partners that submit community-based proposals for funding consideration by PARIMA. Quarterly progress reports are posted at the PARIMA web site ([www.cnr.usu.edu/research/crsp](http://www.cnr.usu.edu/research/crsp)). We are meeting our goals in this activity. The leaders of this activity have been Drs. Solomon Desta and Layne Coppock, with assistance provided by Mr. Seyoum Tezera, Dr. Getachew Gebru, and numerous project collaborators.

#### DEVELOPMENT IMPACT

Perspectives on development impact are the same as in previous GL-CRSP Annual Reports. These are summarized as follows.

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

**Agricultural Sustainability.** A sustainable agriculture is one where interventions are: (1) beneficial—or at least neutral—for the environment; (2) socially acceptable; and (3) economically profitable. The premise behind our project is that, left to

their own devices, traditional pastoral or agro-pastoral production systems in our study region are unsustainable. For example, there is a loss of land to population growth and environmental degradation. There is an unraveling of the traditional social order in some cases, which can often be traced to competition for limited resources. There is abundant evidence that whether due to poor demand, bad infrastructure, and/or inadequate marketing strategies of producers, pastoralism in the region is typically unprofitable. Evidence of unsustainability includes things like the chronic need to feed tens of thousands of people in the region each year, the relocation of poor households nearer to towns and settlements where they engage themselves in petty trade to stay alive, and the increasing poverty and declining living standards of pastoralists in general. By coming up with risk management tools, which in part should allow pastoralists and agro-pastoralists to save and invest outside of their traditional sphere, the resulting investment surge for education and entrepreneurial activity in towns and settlements should primary lead to growth of local economies with benefits for the environment, social order, and pastoral economy. As outlined immediately above, our risk management interventions range from neutral to positive for the environment, which conforms to the first criterion of sustainable agriculture. Accumulation of wealth and efforts to mitigate social conflicts should allow the social fabric to heal—poverty is bad for the maintenance of traditional cultures. This fits the second criterion. The third criterion is dealt with by several economic outcomes that vary in terms of the relevant time scale. Short-term benefits would include an expansion of local markets for pastoral products. Longer-term benefits would include allowing more pastoralists to emigrate out of the traditional

sector due economic diversification and increased employment opportunities in towns and settlements. Facilitation of emigration is the ultimate humanitarian solution to the risk-management dilemma for pastoralists. This is because population growth reduces resources per capita and therefore increases vulnerability of populations to endogenous and exogenous shocks.

### **Contributions to United States Agriculture.**

The main contribution of this project to United States agriculture is primarily in terms of providing a “wake-up call” for research and extension professionals to the importance of risk management for the small to average-sized livestock producer. As will be noted below, the need for risk management by American producers may be increasing as profit margins get slimmer and the social and economic complexity of agriculture increases. It is fair to say that a commodity perspective has been pre-eminent in agricultural research and outreach in the United States. This has contributed to a lack of a relevant systems approach that could better integrate academic disciplines and deal more effectively with real-world problems. Risk management can be an important contribution in this regard. Risk management is simultaneously economic, social, and ecological. The ability to better manage risks is an important attribute of successful farmers and ranchers. While livestock producers in the United States are under no imminent threat of starvation or extreme destitution comparable to pastoralists in northern Kenya or southern Ethiopia, there are commonalities in terms of how risks are conceptualized and interact to cause problems. For example, it has been forwarded by Holechek et al. that beef producers in New Mexico should diversify their assets and investments to mitigate economic downturns

that repeatedly result from cyclic fluctuations in beef prices. This is exactly the same concept that we have for East African pastoralists. Education and access to investments are the main constraints for New Mexico ranchers—similar to prominent implementation constraints for East African pastoralists. The predictability of drought cycles and the possible influence on precipitation regimes of phenomena like El Niño are core issues of agricultural debate in the United States as well as East Africa. Global trade affects the United States beef producer and the East African pastoralist. The advent of the North American Free Trade Agreement (NAFTA) could serve to dampen peak prices received by American cow-calf operators because of increased importation of cheaper Mexican beef. Research remains to be done that could confirm this widely held suspicion. The specter of NAFTA, however, probably influences behavior of American producers by increasing their perceived risk on prices and possibly discouraging production investment. Currently, the cross-border flow of live cattle is officially restricted between Ethiopia and Kenya. We do not know the rationale for this restriction, nor its effects on household economics on either side of the border. Answers to this will be provided by the GL-CRSP's applied research, which may shed new light on the costs and benefits of free trade in general—even as applicable to agriculture in the United States. Our project will communicate such findings and influence the American research community, and hence the United States agricultural community, through a variety of research and outreach publications.

#### **Contributions to Host Countries.**

Contributions to our host countries will mostly be felt through our outreach activities (described above) and training of host-country

nationals. Outreach will primarily have impact on project beneficiaries—pastoralists and agro-pastoralists—but it will also have impact on development professionals and their organizations that link to us directly. In the training sphere our past contributions have also included computers, books, sponsorship for people to attend international conferences, and other technical support for our main academic partner in Kenya, Egerton University.

#### **LINKAGES AND NETWORKING**

This has been previously covered in our section on Outreach.

**Collaboration with IARCs and Other CRSPs.** We collaborate with the International Livestock Research Institute (ILRI) in both Ethiopia and Kenya. We typically hold our workshops at ILRI conference facilities. Some administrative and logistical support for fieldwork is provided to us by ILRI. We have had a link to Dr. Simeon Ehui and the Livestock Policy Analysis Program (LPAP) based at ILRI-Ethiopia. We have been strengthening ties in the past year to the Crisis Mitigation Office (CMO), created under the auspices of ASARECA, headed by Dr. Jean Ndikumana of ILRI-Kenya. The other CRSP we link to is the BASIS CRSP. Drs. Peter Little and Christopher Barrett, American PIs on the GL-CRSP, and Prof. Abdillahi Aboud, regional PI, are also participants on the BASIS CRSP. The GL-CRSP and BASIS CRSP share an interest in policy and economic issues that deal with cross-border relations.

#### **OTHER CONTRIBUTIONS**

**Support for Free Markets and Broad-Based Economic Growth.** Interventions that will be advocated by our project will be in direct

support of free markets and economic growth. Some of this has been previously described. This prominently involves linkages between markets and formation of benefits-oriented cooperatives to empower pastoralists at the local level. At our recent biennial workshop in Njoro during 2001, some presentations dealt with outreach ideas to assist pastoralists to form their own cooperative associations to spur development processes—the idea being that a local association could form and pool capital resources to first organize a community savings and credit association. This would be an impetus for the group to procure production inputs and invest to improve their marketing capability to make themselves less vulnerable to trading bottlenecks. A group, for example, could purchase a large truck and independently handle livestock shipping. The outreach entity would only provide the initial training and a few select inputs to get it rolling. The success of such an endeavor would rely heavily on the availability of livestock and grain markets and their efficiency of operation. Taken together, these elements all reflect the functioning of free markets, a role for agribusiness, and developing a capability for pastoralists to empower themselves using private enterprise.

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

**Concern for Individuals.** Our project incorporates a concern for individuals in several ways. One is through technical and advanced training opportunities, with a focus on host-country nationals at the master's and

PhD level. Training details are given in a subsequent section. Other evidence is provided by the way in which we have organized our applied research and outreach. For research, we realize that improved risk management will ultimately occur at the level of the individual. For outreach, priorities like public education, conflict mitigation, and formation of benefits-oriented cooperatives are a testimony to the value we place on helping individuals improve their lives by being able to deal with risk by making more informed choices.

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

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

#### LEVERAGED FUNDS AND LINKED PROJECTS

During 2001-02 Egerton University has again contributed about USD 7,200 in salary support for PARIMA team members Aboud and Lusenaka, tuition waivers, and stipend support for PARIMA students. Our project is linked to several other groups dealing with outreach and research, but it is difficult to place a monetary value on these relationships. For outreach, we have linkages with a variety of local, grass-roots development efforts. Prominent organizations in the Ethiopian

network include the OADB (Oromia Agricultural Development Bureau), OCPB (Oromia Cooperative Promotion Bureau), and SCF/USA (Save the Children). In Kenya we link to CIFA (Community Initiatives Facilitation and Assistance), the Moyale District Agriculture and Livestock Extension Office (DALEO), and the ALRMP (Arid Land Resource Management Project). For research, our project has a link to several projects. Prof. Abdillahi Aboud and Drs. Peter Little and Chris Barrett, all project co-leaders on PARIMA, also work with the BASIS CRSP as previously described. The PARIMA project is also linked to an effort at Utah State University funded by the Utah Agricultural Experiment Station and led by Dr. Layne Coppock since 1995. This involves identification of prominent threats to the sustainability of Utah ranching operations. The need that Utah producers have for improved risk management is a major issue emerging from this work, and provides an important conceptual bridge between livestock production in the western United States and East Africa.

#### TRAINING

##### *Degree, In Progress:*

Moses Esilaba, MS, 2002, Natural Resource Social Science. Egerton University, Njoro, Kenya.

Clement Lenachuru, MS, 2002, Natural Resource Social Science. Egerton University, Njoro, Kenya.

John Tangus, MS, 2002, Natural Resource Social Science. Egerton University, Njoro, Kenya.

Waktole Tiki Uma, MS, 2002, Natural Resource Social Science. Egerton University, Njoro, Kenya.

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

Abdullahi Dima Jillo, MS, 2003, Natural Resource Social Science. Egerton University, Njoro, Kenya.

Godfrey Nyongesa Nato, MS, 2003, Natural Resource Social Science. Egerton University, Njoro, Kenya.

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

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

##### *Non-Degree Training (Post-Doctoral Associates), In Progress:*

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

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

##### *Completed:*

John McPeak. Post-doctoral associate. 1999-2002. Economics. Cornell University.

##### *Non-Degree Training (Workshops, Short Courses, Field Tours), Completed:*

First Cross-Border Pastoral Women's Tour. Held for one week during late December. Ethiopian women were taken to meet successful women's groups in northern Kenya. Twenty participants including 15 Ethiopian pastoral women and five development agents from Yabelo, Negelle, and Moyale.

Second Cross-Border Steering Committee Meeting for Ethiopia and Kenya. Held for one

day on June 27. Meeting co-hosted by PARIMA and CIFA. The objective was to plan for the upcoming Third General Cross-Border Activity Harmonization Meeting to be held in December 2002. Twenty-four people attended the steering committee meeting, including leaders from the pastoral communities, prominent traders, and local administrators.

Second Short-Course in Small-Scale Business Management and Development. Held the first week of September at Yabelo, Ethiopia. This course was funded by PARIMA and conducted by instructors from the Furra Institute of Development Studies at Yirgalem, Ethiopia. Thirty-two trainees completed the course, and 28 were male and female pastoralists associated with the five community pilot projects sponsored by PARIMA Outreach. The other four were development agents.

The PARIMA team hosted the External Evaluation Panel (EEP) representing USAID Global Bureau. This review was held from June 18-21 and included formal presentations at ILRI Kenya followed by a field tour to southern Ethiopia and northern Kenya. About 15 people attended the ILRI portion, including 10 members of the PARIMA team, two members of the EEP, and observers from ILRI. About 50 people attended various portions of the field tour—the 38-person increment was composed of representatives from local collaborating organizations.

First Policy Makers Tour for Southern Ethiopia. Held the first week of September throughout southern Ethiopia. The purpose of the tour was to help familiarize policy makers from Oromia State—typically department heads of state government—with the development situation in the pastoral zones. The tour was led by Solomon Desta, Seyoum Tezera, and Getachew Gebru and involved about 10 policy makers overall.

## COLLABORATING PERSONNEL

### *United States of America:*

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

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

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

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

### *Ethiopia:*

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

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

Ms. Darlene Cutshall, STI Coordinator, USAID Mission to Ethiopia.

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

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

Mr. Steve McCarthy, Technical Expert, Volunteers in Cooperative Action (VOCA).

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

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

Mr. Aliyu Hussen, Research Coordinator, Oromia Agricultural Development Bureau (OADB).

Ms. Feleketch Lemecha, Senior Staff Member, Oromia Agricultural Development Bureau (OADB).

*Kenya:*

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

Mr. Frank Lusenaka, Lecturer, Department of Natural Resources, Egerton University.

Dr. Jean Ndikumana, Team Leader, Crisis Mitigation Office (CMO), International Livestock Research Institute (ILRI).

Mr. Chachu Tadecha, Director, Community Initiatives Facilitation and Assistance (CIFA).

Ms. Miriam Cherogony, Staff Member, K-REP Development Agency.

Ms. Allyce Kureiya, Staff Member, SNV-Isiolo.

Mr. Boru Halake, Staff Member, Arid Lands Resource Management Project (ALRMP).

Mr. Godana Doyo, Staff Member, Arid Lands Resource Management Project (ALRMP).

Dr. William Shivoga, Senior Lecturer, Department of Environmental Sciences, Egerton University.

Dr. Daniel K. Too, Senior Lecturer and Chair, Department of Natural Resources, Egerton University.

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

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

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

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

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

*Ethiopia:*

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

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

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

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

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

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

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

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Desta, S. 2001. Cattle population dynamics in the southern Ethiopian rangelands. Research Brief 01-02-PARIMA. Global Livestock CRSP, University of California, Davis. 4 pp.

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trader networks in northern Kenya and southern Ethiopia. Research Brief 01-06-PARIMA. Global Livestock CRSP, University of California, Davis. 2 pp.

Doss, C. 2001. Pastoral social safety nets. Research Brief 01-07-PARIMA. Global Livestock CRSP, University of California, Davis. 2 pp.

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## PRINCIPAL INVESTIGATORS

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## **INTEGRATED ASSESSMENT OF PASTORAL-WILDLIFE INTERACTIONS IN EAST AFRICA: IMPLICATIONS FOR PEOPLE, POLICY, CONSERVATION AND DEVELOPMENT IN EAST AFRICA**

### **NARRATIVE SUMMARY**

During 2001-2002, the POLEYC project (Policy Options for Livestock-based Livelihoods and Ecosystem Conservation) continued to develop and disseminate information requested by decision makers in East Africa for their use in balancing the needs of wildlife conservation with the needs of pastoral land users, while insuring the sustainability of semi-arid ecosystems in Kenya and Tanzania. Our approach is to combine Geographic Information System Technology with computer simulation models of the ecosystems (including the pastoral households which are part of them) to perform Integrated Assessments (IAs) of our study areas. These IAs predict the likely outcomes of possible future actions or events such as human population growth, animal disease control, changes in livestock stocking rates, etc. on wildlife, pastoral livestock, pastoral well-being, and ecosystem health. We have made progress on a variety of activities during the current year.

We completed the IA for the Ngorongoro ecosystem and disseminated the results of that analysis to all of our stakeholders, including the Ngorongoro Conservation Area Authority and the pastoralists living within the area. This analysis included the probable effects of continued human population growth and estimates of carrying capacity of the area for wildlife and livestock. Dissemination of results included written materials in Swahili and oral presentations in Maa. The oral presentations in the NCA were very well attended, reaching

over 1,000 pastoralists living in the area.

Progress was made in adapting our models to the Kajiado system and we collected much of the data needed to drive the models for that application. Scenarios to be examined were defined by stakeholders in the area, and many of them center around the effect of subdivision and privatization of land. A veterinary disease survey was completed for the area, and information on watering points and critical wildlife habitats was gathered. A meeting was held with group ranch representatives at which we presented our IA approach and the results from our analysis at NCA. This workshop increased local interest in our project and was very helpful in defining the scenarios to be investigated.

Initial work towards the IA at Tarangire/Manyara was completed. Contacts with important stakeholders in the area were established, and a compilation of existing data and information in the areas was obtained. The groundwork was laid which will permit the collection of all required data for the IA during the next two years.

Work was initiated in the Greater Meru ecosystem. We worked with our collaborators at the Kenya Wildlife Service to define goals for the analysis there. A vegetation map is being developed and important stakeholders identified. J. Kinyamario has initiated a literature review of information pertinent to our analysis there. Plans for the continuation of this work during the coming year were formalized.

Our modeling system was improved in a variety of ways during this period as well. The ecological model was changed to make its adaptation to new sites simpler and to allow it to be applied over larger spatial areas. The household economic model was modified to permit its application to areas in which pastoral households are more deeply involved in the market economy than is the case in Ngorongoro, where it was initially applied.

## RESEARCH

### **Activity 1: Integrated Assessment of the Ngorongoro Conservation Area, Tanzania**

Objectives identified for 2001-2002:

*a. Improve, streamline, and otherwise refine the current version of the NCA integrated assessment package to fit the dimensions of the problem as defined by East African scientists, collaborators, and the NCAA staff.*

The SAVANNA application to NCA was updated, using the newest version of the model, and incorporating significant improvements. For example, whereas in the previous model cattle were simply prevented from grazing in the short grass plains in the wet season because of malignant catarrhal fever, in the new model, cattle avoid migratory wildebeest. This process-based approach allows more flexibility. SAVANNA/PHEWS was adapted to disconnect households and cultivation, allowing cultivation to be separate from households. Modeled animal densities were refined using Management Zones defined by NCAA. The PHEWS model was modified to be appropriate for the new version of SAVANNA. This was important to do in order to realistically address the management

questions posed by the NCAA. This activity directly addresses the goal in the initial problem model to initiate a demand-driven integrated assessment (IA).

*b. Develop Integrated Assessment scenarios of the effects of alternative policy decisions and management actions on human economic status, livestock production, wildlife populations, and ecosystem state.*

Discussions were held with the NCAA to solidify the general questions to be addressed by POLEYC. These were followed by a series of meetings at CSU to define detailed integrated assessment scenarios. Victor Runyoro of the NCAA spent two weeks at CSU, contributing to IA scenario development and receiving training on SAVANNA and remote sensing techniques. The scenarios dealt with appropriate stocking rates in NCA, area under cultivation and its distribution, livestock disease control, and human population growth. Addressing the scenarios required integrating information, GIS analyses, and ecosystem and socioeconomic modeling. A combination of methods to estimate herbivore carrying capacity was used in NCA. Cultivation was mapped using remote sensing (Fig 1). The cultivation map was reformatted to be used in SAVANNA, and modified to change the distribution and area of cultivation for different scenarios. Ecological Modeling was conducted, and results presented in a form useful to decision makers. Analyses focusing specifically on the PHEWS model were conducted. Although we had not initially planned to have Victor Runyoro visit, his trip did allow us to focus on IA scenario development. His trip and subsequent IA analyses at CSU permitted him to present the results of the NCA analyses at a very important NCAA workshop. The analyses and development recommendations are found in Runyoro et al. (in press).

c. Present results of IA scenarios to: 1) the NCA Authority and its parent ministry; and 2) the Maasai community in NCA and a few NGOs supporting Maasai development.

Integrated assessment results were presented to members of the NCAA and other scientists in January of 2002. We agreed to a request by NCAA that they pass POLEYC results on to their parent ministry. This process is ongoing. We presented assessment results to the NCA Pastoral Council, with presentation content and selected visuals translated into KiSwahili. We presented results to pastoralists in Endulen, with presentation content in Maa. Members of the Danish-supported project *Ereto* attended each of these meetings. These results were discussed in community meetings in six sites within NCA during mid-September. Over 1,000 local Maasai pastoralists attended these meetings. Results from NCA were presented to a wider audience in East Africa, as a demonstration of the integrated assessment process and potential results.

A scientific report of POLEYC results has been provided to members of the NCAA, *Ereto*, and the Pastoral Council. A condensed version of POLEYC results using lay language was translated, used in community meetings, and provided to the Pastoral Council and pastoral community leaders. The report is available on the POLEYC/IMAS website at: <http://www.nrel.colostate.edu/projects/imas/>



Figure 1 - Cultivation in Ngorongoro Conservation Area, Tanzania, shown in black, for February 2000. Within the conservation area, 3,967 ha or 9,803 ac were mapped as cultivation. For context, a 5 km buffer around Ngorongoro Conservation Area is also shown.

webpubs.html. Papers have been prepared to disseminate results to the scientific community and multiple research briefs are in preparation (see Publications section below for listing).

We have gone beyond the tasks expressed in the problem model, not only to present results in several languages but also to obtain feedback from all constituencies. This activity has been very important to the acceptance and use of the IA by stakeholders.

### **Activity 2: Integrated Assessment of the Amboseli Group Ranches, Kajiado District, Kenya**

Objectives identified for 2001-2002:

*a. Improve and adapt the POLEYC integrated assessment package to fit the question of subdivision for the Amboseli Group Ranches: 1) Refine PHEWS to better represent household economic activities in the Amboseli region, and 2) Refine SAVANNA to represent ecological constraints and subdivision issues in Kajiado.*

Philip Thornton made an extended trip to CSU from ILRI in May 2002 in order to begin adapting the PHEWS model to reflect the more diversified economic situation characterizing pastoral production strategies in the Amboseli group ranches. A second trip to NREL to

finalize this adaptation of the model was made in October, following the GL-CRSP 2002 Program Conference. Randall Boone has made substantial progress in parameterizing the SAVANNA model to address the subdivision questions that will form the foundation for the Amboseli Integrated Assessment. Initial progress on an approach to look at subdivision impacts on pastoralists and their livestock was demonstrated at the EEP review meetings in June 2002. The refinement of PHEWS based on data from Kajiado is close to completion and should be finished early in 2003. The SAVANNA adaptation to Kajiado is complete and some results can be found in BurnSilver et al (in press).

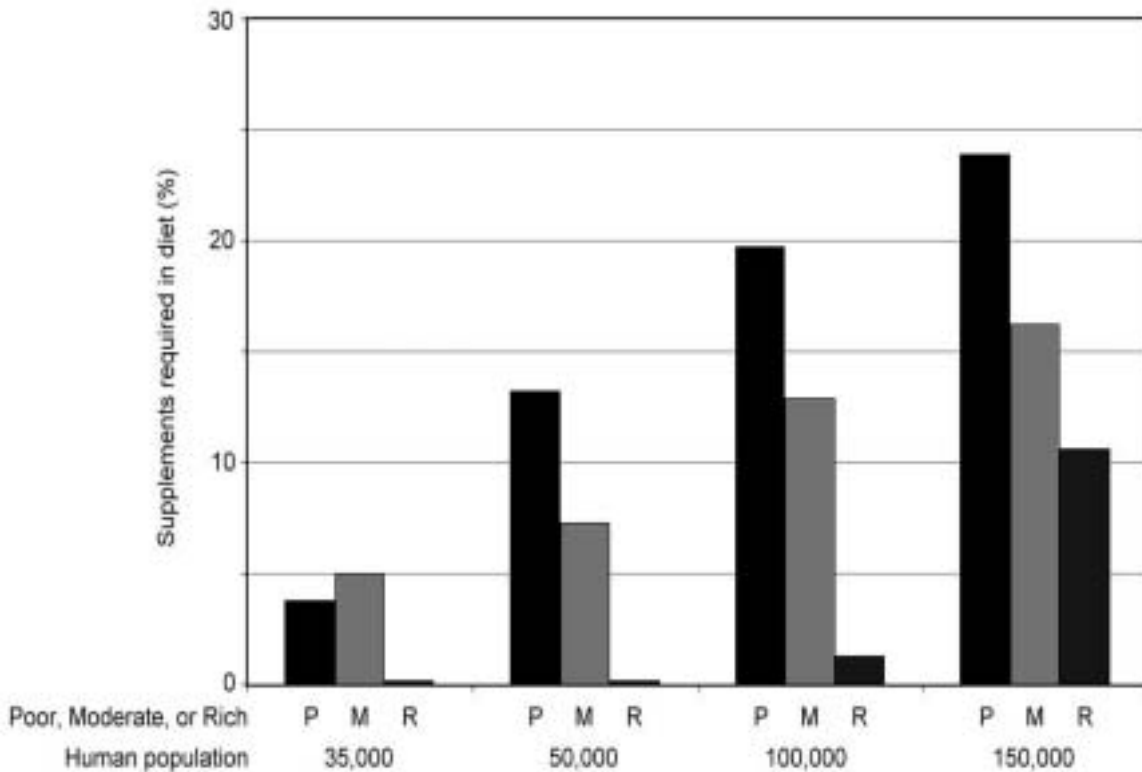


Figure 2 - Supplemental foods, such as relief aid, required by Maasai under different human populations and correspondingly increasing cultivation. Results are shown for poor, moderate, and rich households.



*Figure 3 - Participants in one of six community meetings held in Ngorongoro Conservation Area in mid-September, 2002. Up to 350 Maasai attended each of these dissemination meetings.*

*b. Develop Integrated Assessment scenarios that illustrate alternative management decisions regarding subdivision and land use on human economic status, livestock production, wildlife populations, conflicts between people and wildlife, and ecosystem state.*

The list of critical issues from the January workshop in Loitokitok (*see additional activities below*) became the foundation for development of IA scenarios for the Amboseli project area. Focus groups with Amboseli group ranch members in February 2002 also highlighted the range of subdivision options actually under consideration by group ranch members and leaders. Between March and June of 2002, these critical issues were recast as scenarios that illustrated potential tradeoffs on a range of issues for pastoralists, livestock, and wildlife. These scenarios were then translated into KiSwahili, and English and KiSwahili versions were disseminated for comment to group ranch representatives and important stakeholders in Kajiado and Nairobi. The comment period was open through the fall of 2002, and adjustments to the IA scenarios are being made currently on the basis of comments from POLEYC collaborators. A final version of these IA scenarios will be ready in early

2003. The scenarios relate to subdivision, carrying capacity of the system for livestock and wildlife, wildlife-livestock interactions, and human economic activities. The PHEWS-SAVANNA IA system is currently being adapted for Kajiado. The analyses will be complete early in 2003.

*c. Collect ecological and economic field survey information needed to develop and improve integrated assessment scenarios and analyses.*

Shauna BurnSilver finished collecting socio-economic field data for her PhD study in the Amboseli group ranches in March 2002. Economic and land use data from this study are being used by Joana Roque de Pinho (PhD student NREL/CSU and 2002 J. Ellis Mentorship Program Awardee) as a baseline to focus her study on determining Maasai 'attitudes' toward wildlife, the strength of these attitudes, and the reasons they are held. Joana Roque de Pinho will gather additional data on economic costs/benefits associated with wildlife and ecotourism activities, and non-economic valuations of wildlife by Maasai of different age and gender groups. She plans to complete her field studies in February of 2003. Early results suggest that different areas of Kajiado are experiencing different types of

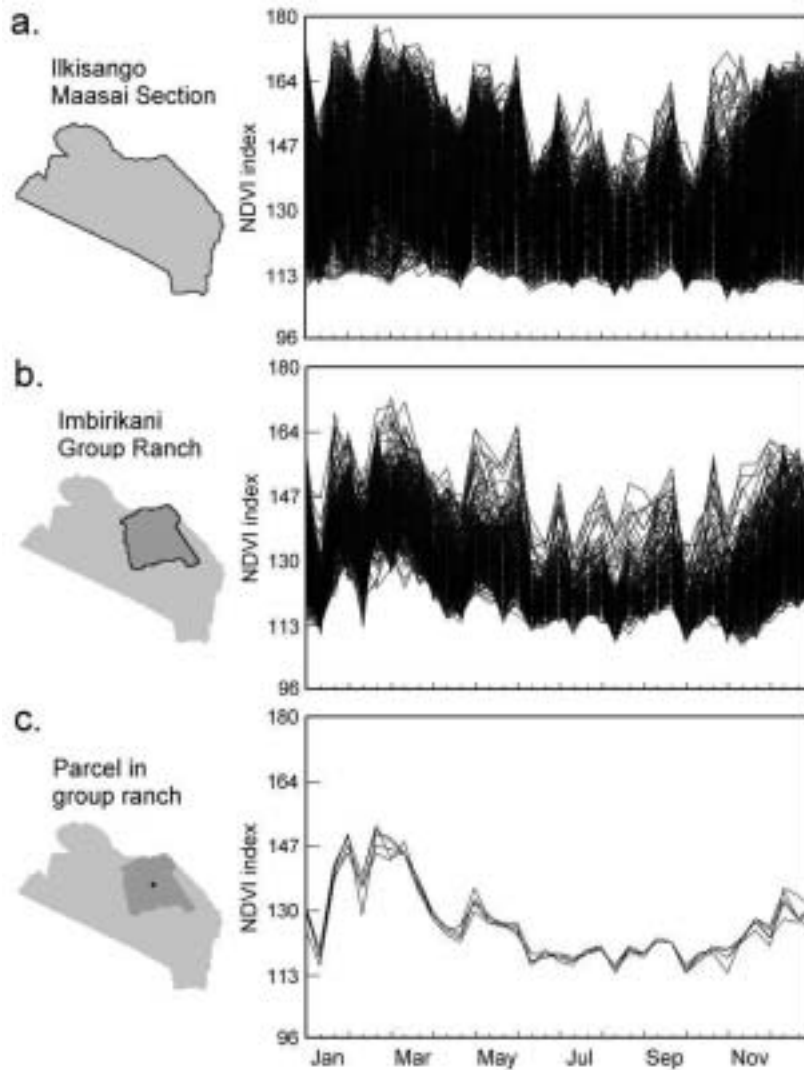


Figure 4 - Diversity of vegetation responses based on satellite images, for each 1 km<sup>2</sup> within southern Kajiado District, and reflecting the diversity of options available to livestock herders that use the parcels exclusively. In Ilkisingo Section (a), a wide diversity of landscape patches are available to herders; in Imbirikani Group Ranch (b), fewer options are available, with landscape patches greening up or senescing at similar times; and in a small parcel within the group ranch (c), vegetation responses are essentially overlapping and few options available to the landowner.

human-wildlife conflicts. In Imbirikani, elephants in particular are causing extensive crop damage, which residents are finding unacceptable. Lions are also being poisoned, a practice not culturally sanctioned but one that is becoming prevalent in this densely populated area. In Imbirikani Group Ranch, where benefits derived from wildlife-based tourism are substantial, the knowledge that these benefits are linked to wildlife is widespread. Wildlife is nevertheless regarded as a nuisance.

Jeff Worden (PhD student NREL/CSU) has continued his fieldwork in the Amboseli

group ranches, focused on documenting current and historical land use patterns of pastoralists and their effects on vegetation patterns at multiple scales. Some conclusions include: 1) sedentarization is increasing across all sites, 2) there is increased dispersion in the spatial pattern of settlement with subdivision, and 3) there is a reduction in the scale of resource use with increasing sedentarization, as well as fragmentation and a concomitant reduction in the size of grazing reserves. Jeff Worden will finish his work in early 2003.

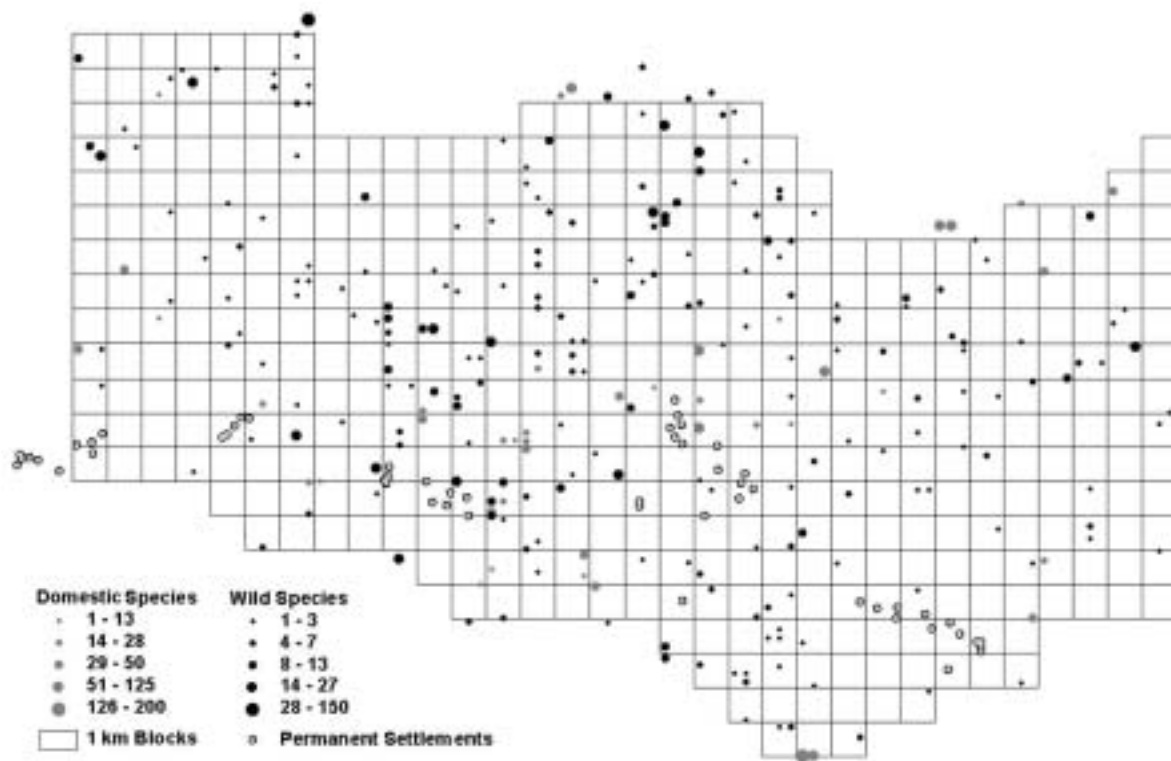


Figure 5 - Distributions of wild and domestic herbivore species in the Meshanni Ridge area north of Amboseli National Park, Kajiado District, Kenya, during the dry season of 2000 (J. Worden, thesis data). Herbivore and settlement distributions are from aerial surveys.

The data from these projects are essential to either: 1) IA adaptation and scenario runs, or 2) interpreting stakeholder concerns and their perceptions of the IA results.

Additional Activities carried out in Kajiado 2001-2002:

*a. Presented results of NCA Integrated Assessment to Kajiado Group Ranches and KWS as an example of how IAs can be used in policy and planning.*

Results of the IA for the NCA were presented to a combined group of 25 Group Ranch and stakeholder representatives (KWS, the Amboseli Tsavo Group Ranch Conservation Association, the African

Conservation Centre, and SARDEP) at a workshop in Loitokitok, Kajiado in January 2002. Workshop participants used this example of NCA IA scenarios to generate an initial list of ‘critical issues’ that they considered important in Amboseli. These related to subdivision, carrying capacity of the system for livestock and wildlife, wildlife-livestock interactions, and human economic activities. This activity relates directly to Activity 2b and has been very helpful in scenario development.

*b. Initiate disease assessment fieldwork to identify important wildlife-livestock disease relationships.*

In collaboration with the District Veterinary Office of Kajiado, a team of two veterinarians began field studies in early August 2002 in 6 study areas across four Amboseli group ranches. The duration of the study was one month, and the goals were to identify significant livestock-wildlife diseases in the Amboseli area, identify disease hot-spots on the landscape and highlight important pastoral coping strategies. Results of the study will be integrated into the IA for the Amboseli area, and will be publicized in a wildlife-livestock disease research brief. This was conducted because disease is an important component of wildlife-livestock interactions. Our work on this issue is a result of workshops and subsequent referrals to us as being something important we could and should address.

*c. Collect and synthesize additional data layers on water point distribution and critical wildlife habitats/connectivity.*

Working with M. Nyabenge (GIS specialist at ILRI), 2 Maasai field assistants were in the field (September 2002) collecting GPS data on existing water points in order to fill in gaps identified in the GIS data layer for SAVANNA. Jeff Worden was also working with D. Western during this period to use wildlife count data and aerial photos of the Amboseli group ranch area to identify the spatial extent of critical wildlife corridors and habitats. These data will be an important element in the Amboseli Integrated Assessment based on scenarios developed with the collaborators.

### **Activity 3: Integrated Assessment of the Tarangire/Manyara Ecosystem, Tanzania**

Objectives identified for 2001-2002:

*a. Establish working relationships with agencies and NGOs active in the TME.*

This task was successfully completed, but due to the large number of active organizations in this region, new relationships continue to arise. A POLEYC team demonstrated the IA approach and capabilities based on results from the NCA Integrated Assessment to TME collaborators in January 2002. Agencies and NGOs include Tanzania National Parks, Tanzania Wildlife Research Institute, OIKOS (Italian), Inuuyat e Maa (Maasai pastoralists), African Wildlife Fund, Manyara Ranch, Conservation Information Centre, and local community leaders.

*b. Develop literature-based and spatial databases for the Tarangire/Manyara ecosystem.*

Considerable progress was made in this area, both as preparation for model application, and for planning field research conducted by Stacy Lynn. A literature review is underway for the TME to identify and organize previous research and grey literature sources that relate to integrated assessment issues identified for the TME. An existing literature review for the project area performed by Clive Jones (Director of Manyara Ranch) in 2001-02 was made available to us by Mr. Jones. This has proven to be an invaluable resource for us and it has been augmented by Stacy Lynn during her work in the area. A Landsat satellite TM scene was purchased (by ILRI) as the basis for development of a vegetation data layer, and GIS layers on animal movements for domestic and wild species, Maasai settlement locations, and water points are being assembled based on collaboration with the organization OIKOS.

*c. Conduct field reconnaissance of the ecological conditions of the TME.*

The area was visited during the January field campaign organized by Allan Kijazi, Jim Ellis, and Shauna BurnSilver, with participation by Boone, Coughenour, DeMartini, Roque de Pinho, Thornton, and African collaborators. Stacy Lynn was in the field for 3 months (May – July 2002) conducting more in-depth reconnaissance to plan the main portion of her fieldwork, to be conducted in 2003. Her work in gathering GIS data layers has been supported by GIS personnel at ILRI (Nyabenge, Serneels). Terry McCabe worked with Stacy for several weeks during this period as well, identifying land allocation mechanisms that are affecting both the rate and direction of Maasai land use change.

*d. Initiate field research on conflicts and constraints to conservation and development in the TME.*

Initial progress has been made on this objective, initiated by Stacy Lynn's 2002 fieldwork. She and Terry McCabe conducted several focus groups with TME Maasai to define appropriate questions and boundaries for the overall TME study. In addition to meeting local people, meetings were held with several important land managers from Tarangire National Park, TANAPA, TAWIRI, AWF, Manyara Ranch, Simanjiro District, and others. She also cleared the research plan with COSTECH and obtained all necessary research permits for this project. She returned from the field in mid-August 2002. The next phase of work will focus on collection of data to be used in the IA through interviews with local people, as well as with a wide variety of stakeholders, NGOs, and agencies. A final research proposal

has been prepared, incorporating findings from the 2002 trip.

Terry McCabe's work in Tarangire concentrated on land use, land use change, and wildlife – pastoral conflicts in the region. His results indicate that the system of land use is undergoing a rapid change involving a transformation to large-scale, mechanized agriculture in the savannas east of Tarangire. This change is a clear threat to use of the areas as wildlife corridors or migratory routes. This land use change is being driven by a number of factors, not the least of which is the new view the area Maasai have of themselves – as an agro-pastoral people, practicing a livelihood strategy based on both livestock and cultivated agriculture. Their involvement in the Tanzanite business provides many of them with money to buy tractors and other agricultural inputs that can change the spatial scale of cultivation drastically. This appears to be a critical time for land use systems in this region. In general, younger men lean toward complete privatization and subdivision, whereas older men would like to see much of the area remain open to all as common grazing land. The way in which these competing views play out will have important impacts on the future of pastoralism and wildlife conservation in the area. Formal data collection for the IA will be conducted from January through August 2003.

*e. Collect field ecological and economic survey information needed to develop and improve Integrated Assessment scenarios and analyses.*

This activity is largely postponed for the main portion of Stacy Lynn's field research, beginning in January of 2003. Terry McCabe also will collect data in two TME locations for use in parameterizing the PHEWS model.

*f. Initiate efforts to adapt PHEWS and SAVANNA models to the TME.*

This is addressed in the section on model development.

#### **Activity 4: Integrated Assessment of the Greater Meru Ecosystem, Kenya**

Objectives identified for 2001-2002:

*a. Work with KWS to define specific goals for Integrated Assessment associated with their restoration efforts in the Greater Meru Ecosystem (GME).*

In consultation with employees of KWS in Nairobi and with the Chief Warden of the park (Mark Jenkins), a list of preliminary problems and/or issues that the IA could address was developed following a trip our group made in January 2002. As an introduction to the POLEYC approach and capabilities, a team demonstrated Integrated Assessment results from the NCA to KWS scientists at KWS Headquarters in Nairobi. Subsequent issues identified for the GME include: competing land uses (pastoralism, joint wildlife/livestock enterprises, ecotourism), increased human settlement in the GME, unauthorized incursion into the Park proper by Borana and Somali pastoral populations to the north, wildlife translocation issues, effects of elephant populations on vegetation, the effects of fencing on corridors/connectivity between different reserves, wildlife and livestock disease, and loss of water resources in the park due to outside uses. In addition, the IA must be developed in such a way as to be useful to KWS in the development of their 1-year, 5-year and 20-year master management plans for the GME.

*b. Conduct field reconnaissance of ecological conditions in the GME.*

Development of a vegetation map is currently underway. Graduate student John Otuoma of the University of Nairobi, using a cover map developed by AFRICOVER, is doing this work under the direction of Dr. Jenesio Kinyamario. During the year, various members of the POLEYC team have been to the GME to familiarize themselves with ecological and socio-economic issues there. These include: J. Ellis, M. Coughenour, S. BurnSilver, R. Boone, J. DeMartini, J. Roque de Pinho, D. Swift, J. Mworira, P. Thornton, M. Mulama, W. Mutero, and J. Otuoma.

*c. Conduct a preliminary analysis of community attitudes and socio-economic conditions among local Borana herders and Meru agro-pastoralists.*

This work on assessing community attitudes is ongoing. It is being conducted by Kenyan consultants reporting to KWS and working with SOFRECO, a French development group. D.Swift, W.Mutero, and J. Otuoma met with this team in Meru National Park in July to discuss potential sharing of this data and of socio-economic data already collected by SOFRECO.

*d. Initiate literature-based and spatial databases for the GME.*

Jenesio Kinyamario has undertaken a review of all available open and grey literature publications that deal with socio-economic and ecological conditions in the GME. The review entailed two trips to the GME to visit government offices and NGOs in the area, which allowed the POLEYC team to both identify data sources and make additional

contacts with local NGOs and stakeholders currently working in the GME.

*e. Conduct training and promote GIS database development for the GME at KWS headquarters in Nairobi and at the GME Research Center in Meru National Park.*

Training and the promotion of GIS development for the Greater Meru Ecosystem (GME) at Kenya Wildlife Service (KWS) and Meru National Park were proposed. A visit to the park confirmed that facilities are not yet advanced enough to be used for the training of groups, and GIS training at KWS focused on GME is premature - spatial layers for the area are too scarce. Instead, we focused on database development. For example, John Otuoma, a student working with Jenesio Kinyamario, is creating a vegetation map for the region. Preliminary analyses of community attitudes were also proposed. However, we have postponed these analyses pending the outcome of a literature review. We are now aware of recent and ongoing socio-economic work in GME supported by other nations, and do not wish to duplicate efforts. After the literature review compiles existing information, we will re-evaluate our socio-economic objectives.

### **Activity 5: Model Development and Adaptation**

Objectives identified for 2001-2002:

*a. Refine and streamline SAVANNA for easier adaptation to new CRSP sites.*

Version 5a of the model was developed during this time period. This version includes improvements that will make the model easier to adapt to new sites, as well as a variety of

more general improvements. All the details of the model improvements cannot and need not be described here. As examples, however: a) the weather routines were generalized to accommodate large spatial domains, b) the initialization process for vegetation submodel was streamlined, c) the graphical user interface (SAVANNA Modeling System or SMS) was refined and updated, d) more straightforward data inputs for the soil decomposition and nutrient cycling submodel were developed, e) GIS inputs from the newest version of IDRISI (IDRISI-32) were enabled, and f) we began work on developing plant and animal parameter files that will be generally applicable across a wide range of systems in East Africa. This task should be completed early in 2003.

*b. Modify PHEWS to better accommodate a variety of economic conditions relevant at different sites.*

The adaptation of the PHEWS model to Ngorongoro Conservation Area entailed modeling households weakly tied to local and regional markets. In other POLEYC sites, especially in Kajiado, decisions made by pastoralists and agro-pastoralists are more tightly tied to market conditions. In PHEWS for NCA, livestock were purchased and sold at fixed prices. In Kajiado, prices are associated with market conditions. There is a large diversity of land use types across Kajiado Maasailand as well, with households raising livestock only, livestock and rain-fed crops, livestock and irrigated crops, employment in local businesses, etc, and these responses vary among group ranches. PHEWS has therefore been modified from the original 3 household categories (poor, medium, and rich) to include 9 household categories identifiable in the Kajiado area.

*c. Begin model adaptation to new sites.*

The new sites are Tarangire and Meru. The model adaptations have just begun. The first step in model application to a new site is simply to become familiar with the site and the key issues. This then enables a general design for model configuration, in terms of identifying the spatial domain, the relevant plant and animal functional groups, management scenarios, etc. This process is underway for both sites, based upon information obtained in workshops, field reconnaissance, and interviews. Considerable progress has been made on research into data inputs to the model for the Tarangire site. We have identified and procured key data sources from literature and unpublished reports. We have also made contacts with people and projects who have critical data needed to run the model. Progress in Meru has been slower, as there are fewer existing data sources. There has been far less research conducted there than in Tarangire; however, our Kenyan collaborators are making good inroads into procuring the data that are available. A PHEWS application for Meru/Tarangire is not yet initiated.

**Activity 6: Regional Analyses**

Objectives identified for 2001-2002:

*a. Begin regional analyses of pastoral wildlife interactions using GIS and remote sensing data.*

This work is the PhD dissertation of Joyce Acen, a graduate student from Uganda whom we have been training for the last 3 years. She has completed her coursework as of spring term 2002, and is engaged in her research full time. The objective is for her to finish her work

and her dissertation by the end of the 2002/2003 funding cycle. Joyce spent 3 months at ILRI in 2002 working with Russ Kruska, Meshak Nyabenge, and Suzanne Serneels to begin a synthesis of regional databases for her work. Ms. Acen's work will center on an analysis of spatial and temporal patterns of change in range condition (or evidence of range degradation), and how these relate to large herbivore densities. She will also investigate the effects of increasing crop agriculture on livestock density and productivity.

**GENDER**

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

**POLICY**

The Integrated Assessment applications that we plan are directly policy-oriented. In these situations, contentious issues having to do with land use and conservation policy are

under review and policies are very likely to be changed. Our IA applications have an excellent opportunity to enlighten policy makers about the probable outcomes of their alternative policy choices. Some of these applications are also management-oriented (Meru). In these cases, policies may also be influenced by weighing the results of the IAs and the implications for development and conservation policy, nation-wide.

### OUTREACH

Our outreach targets are many, and our approaches vary depending upon our audience. We disseminate our results to all decision makers who have an impact on resource management in the pastoral zones of Kenya and Tanzania. This includes individual pastoral herd owners and their families who make a multitude of decisions about marketing, stocking rates, animal disease control, coexistence with wildlife, and other issues. This has been accomplished by disseminating our results in non-technical language, in written reports in KiSwahili, and in oral presentations in Maa. We also interact with NGOs in the pastoral zones, and with pastoral groups such as the group ranch committees in Kajiado. These communications include those described above, as well as more technical English language reports, where appropriate. We provide results that are useful to the management staff of our institutional collaborators, such as NCAA and the Kenya Wildlife Service. We interact with decision makers in government ministries that are responsible for decision making in the pastoral zones. These communications take the form of face-to-face meetings and workshops designed to describe our IA approach and the

results we have obtained. We maintain open communication with the USAID Missions in both countries, briefing them on our work and providing them with our reports. We continue to develop "Research Briefs," suitable for most of the non-technical audiences mentioned above.

### DEVELOPMENTAL IMPACT

Our Integrated Assessment approach was developed to address issues of conflict and complementarity between conservation and livestock development in arid and semi-arid portions of East Africa, where wildlife and pastoralists have traditionally shared the ecosystem. GL-CRSP support provided an opportunity to begin to apply models and other aspects of integrated assessment to problems related to livestock development. These technologies have, heretofore, been used only to a limited extent in this sort of development context. Our development-relevant goals are to assist pastoral people, policy-makers, and agencies in weighing alternative development and conservation strategies before implementing development or conservation policies and procedures that may be problematic. As a result of demonstrations and work carried out in the first phase of our GL-CRSP project, and due to our outreach and communication activities, we have been asked by conservation agencies (i.e., NCAA), wildlife, land, and conservation management agencies (i.e., KWS), and pastoral people (i.e., Amboseli-Tsavo Group Ranch Conservation Association) in East Africa to assist them in development planning using integrated assessment. As we continue with these applications, the results will benefit the host countries in terms of development and conservation planning, as well as policy analysis. This project has a large team, with a

net result of creating multiple linkages with numerous agencies and institutions in East Africa. IARC collaboration is through ILRI, our primary collaborator.

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

**Agricultural sustainability.** The IA approach that we use (incorporating the SAVANNA modeling system) emulates long-term ecosystem dynamics, enabling us to determine if specific management actions are likely to lead to sustainable resource exploitation strategies.

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

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

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

**Collaboration with international research centers (IARCs) and CRSPs.** One of our most important collaborators in the project is ILRI. We work closely with Robin Reid, Phillip Thornton, and Mrigesh Kshatryia of that organization, among others, on many aspects of the project.

#### OTHER CONTRIBUTIONS

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

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

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

#### LEVERAGED FUNDS AND LINKED PROJECTS

The following projects contributed leveraged funds to GL-CRSP POLEYC during the period July 1-Sept 30, 2002:

USDI/USGS/BRD- PI: Mike Coughenour: “Spatial Ecosystem Modeling of Yellowstone Bison and the Environment.” Total Award \$113,034. Project Period: 6/97-5/02. Project uses SAVANNA Ecosystem Model to model interactions between bison populations and vegetation in Yellowstone N.P. Model

parameterization and testing in this case contribute to GL- CRSP modeling activities in East African Sites.

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

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

NOAA Office of Economics and Human Dimensions of Climate Fluctuation- PI: Kathleen Galvin: “Responses to Climate Variability and Utility of Climate Forecast Information for the Livestock Sector in Arid and Semi-Arid Zones, South Africa.” Total Award \$358,914. Project Period: 7/98-7/02. Phillip Thornton developed a model to identify the impact of climate variability on household economy. Both Thornton (ILRI) and Boone (NREL/CSU) linked the household model to the SAVANNA ecosystem model. Funds from the NOAA grant were leveraged to the GL-CRSP to help Thornton and Boone link the SAVANNA and PHEWS models for applications to the NCA and Kajiado GL-CRSP sites.

NSF Dissertation Improvement Grant- PhD student Jeff Worden: “Maasai Settlement, Landscape Mosaics, and the Spatial Patterning of Vegetation and Wildlife in East Africa.”

Total Award, \$20,000. Project Period: 5/01-10/02. The PhD research of Jeff Worden is funded through a combination of GL-CRSP and NSF funds. Funds leveraged to the GL-CRSP through NSF have increased the scope of Jeff Worden’s PhD research project.

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

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

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

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

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

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

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

### TRAINING

During the last funding year we supported six PhD students and one master's student. We hosted a number of non-degree training workshops in Kenya and Tanzania, as well as dissemination meetings, and training at CSU for two African scientists in SAVANNA and IA methodology.

### *Degree:*

Joyce Acen (Uganda), PhD student; degree date: 2003; Ecology; Colorado State University.

Jeff Worden, PhD student; degree date: 2003; Ecology; Colorado State University.

Shauna BurnSilver, PhD student; degree date: 2003; Human Ecology; Colorado State University.

Stacy Lynn, PhD student; degree date: 2004; Ecology; Colorado State University.

Joana Roque de Pinho (Portugal), PhD student; degree date: 2004; Human Ecology; Colorado State University.

John Otuomo (Kenya), M.S. student; degree date: 2004; Botany; University of Nairobi.

Oltisatti Kamuaru (Kenya), PhD student; degree date: 2004; Range Ecology; University of Nairobi.

### *Non-degree:*

Stacy Lynn – Wilderness Transponder First-Aid Training. Colorado State University Outdoor Program.

IA Demonstration Workshop – January 24, 2002. Location: Loitokitok, Kenya. Participants: Group Ranch and local NGO representatives. Presenters: Jim Ellis, Randall Boone, Shauna BurnSilver.

Focus Group on subdivision issues – February 10-15, 2002. Location: Kajiado, Kenya. Participants: Imbirikani North GR members, Eselengei GR members, Meshenani GR members. Presenter: Shauna BurnSilver.

IA Demonstration workshop at KWS Headquarters.

Mrigesh Kshatriya – trained on SAVANNA at NREL, CSU. Dates: July – August, 2002. Trainers: Randall Boone, Michael Coughenour.

NCA Dissemination of IA results to NCAA management – January 2002, Tanzania. Presenters: Jim Ellis, Randall Boone, Shauna BurnSilver.

NCA Dissemination of IA results to Executive Pastoral Council – January 2002, Tanzania. Presenters: Jim Ellis, Randall Boone, Shauna BurnSilver.

NCA Dissemination of IA results to Maasai community members – January 2002, Tanzania. Presenters: Jim Ellis, Randall Boone, Shauna BurnSilver.

IA Demonstration workshop – January 2002. Location: Tarangire, Tanzania. Presenters: Jim Ellis, Randall Boone, Shauna BurnSilver.

Victor Runyoro – trained in IA methodology at NREL, CSU. Dates: October 2001. Trainer: Randall Boone.

NCA Community Meetings – September 19-24, 2002, Tanzania. Presenters: S. BurnSilver, G. Leboy, M. Kshatriya, M. Nyabenge, A. Mwillawa.

#### COLLABORATING PERSONNEL

##### *Principal U.S. Team Members:*

Michael Coughenour, Senior Research Scientist, NREL

Kathleen Galvin, Senior Research Scientist, NREL

Randall Boone, Research Scientist, NREL  
Shauna BurnSilver, Project Manager and PhD Candidate, NREL

James DeMartini, Professor, CSU

Terrance McCabe, Professor, CU

Jeff Worden, PhD Candidate, NREL

Stacy Lynn, PhD Candidate, NREL

Joana Roque de Pinho, PhD Candidate, NREL

##### *ILRI Principal Team Members:*

Robin Reid, Senior Systems Ecologist, ILRI

Philip Thornton, Research Scientist, ILRI, Nairobi; Edinburgh, Scotland

Meshak Nyabenge, GIS analyst

Joseph Ogutu, Ecologist and Modeller

Leah Muraya, Data Analyst

Mrigesh Kshatriya, Ecosystem Modeler

Suzanne Serneels, Geographer, Remote Sensing

Russ Kruska, GIS Lab Leader

Kamau Kimani, Project Manager and Geographer

##### *Principal Host Country Team Members:*

###### *Kenya*

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

John Mworira, Research Associate, Univ. Nairobi

John Otuoma, MS student, Univ. Nairobi, Dept. of Botany

Jesse Njoka, Professor, Univ. Nairobi

Stephen Mbogoh, Professor, Univ. Nairobi

Mrigesh Kshatriya, Research Scientist, ILRI

Kamau Kimani, Research Associate, ILRI

Jackson Wandera, Land Use Planning Coordinator, SARDEP

Wilber Ottichilo, Director General, RCMRD

David Western, Director, ACC

Jan Grootenhuis, Veterinarian, Private Consultant

Paul Rwambo, Veterinarian, Private Consultant

Richard Bagine, Research Director, KWS

Wycliffe Mutero, GIS Leader, KWS

Michael Kipkeu, Senior Warden, Amboseli NP

Mark Jenkins, Senior Warden, Meru NP  
P. Ole Kamuaro, Assistant to the Director,  
Natural Environmental Secretariat, and PhD  
Candidate, Univ. of Nairobi

Nick Georgiadis, Director, Mpala  
Research Centre

James Likampa, Group Ranch  
Representative, Imbirikani

David Salaash, Group Ranch  
Representative, Eselengei

Leonard Partimo, Group Ranch  
Representative, Olgululuri/Lolarashi

Ole Sitaya, Group Ranch Representative,  
Osilalei

Joseph Miaron, Manager, Amboseli/Tsavo  
Group Ranch Conservation Association

*Tanzania*

Allan Kijazi (Tanzanian PI), Acting  
Conservator, NCAA, Ngorongoro

Victor Runyoro, Chief Ecologist, NCAA,  
Ngorongoro

Emmanuel Chausi, Conservator, NCAA,  
Ngorongoro

Emmanuel Gereta, Consultant to  
TANAPA

Angello Mwilawa, Livestock Research  
Scientist, LPRI, Mpwapwa

Francis Ole Ikayo, Director, Inuyat e-Maa  
Peter Toima, Director, Maasai  
Advancement Association, Arusha

Carol Sorensen, ERETO, Ngorongoro  
Gaspar Leboy, ERETO, Ngorongoro  
Cuthbert Nahonyo, Professor, University  
of Dar es Salaam

Elifuraha Mtalo, Director, UCLAS  
Patricia Moehlman, Private Consultant  
Fatheem Banyikawa, Research Scientist,  
SUNY and Serengeti Research Institute

*Uganda*

Joyce Acen, PhD Candidate, NREL

**COLLABORATING INSTITUTIONS**

*Kenya:*

International Livestock Research Institute,  
Nairobi

University of Nairobi

Kenyatta University, Nairobi

Kenya Agricultural Research Institute,  
Nairobi

Kenya Wildlife Service, Nairobi

Regional Centre for Mapping of Resources  
for Development, Nairobi

National Environment Management  
Authority, Nairobi

Mpala Research Centre, Nanyuki

Amboseli/Tsavo Group Ranches  
Conservation Association, Loitokitok

Semi-Arid Regional Development  
Program, Kajiado

African Conservation Centre, Nairobi

PACT CORE, Nairobi

SOFRECO, Clichy, France (working in  
GME)

African Wildlife Foundation, Nairobi

*Tanzania:*

University of Dar es Salaam

Ngorongoro Conservation Area Authority,  
Ngorongoro

Inuyat e-Maa, Arusha

African Wildlife Foundation, Arusha

Tanzanian National Parks, Arusha

Livestock Production Research Institute,  
Mpwapwa

Ngorongoro Conservation Area Authority,  
Ngorongoro

University College of Lands and  
Architectural Studies, Univ. of Dar es Salaam

Executive Pastoral Council, Ngorongoro

OIKOS, Verese, Italy (working in TME)

## PUBLICATIONS

### *Scientific Publications:*

Boone, R.B., M.B. Coughenour, K.A. Galvin, and J.E. Ellis. 2002. Addressing management questions for Ngorongoro Conservation Area using the SAVANNA Modeling System. *African Journal of Ecology* 40:138-150.

BurnSilver, S.B., R.B. Boone, and K.A. Galvin. In press. Linking pastoralists to a heterogeneous landscape: The case of four Maasai Group Ranches in Kajiado District, Kenya. Linking household and remotely sensed data: Methodological and practical problems (Fox, J., V. Mishra, R. Rindfuss, and S. Walsh, eds.). January 2002.

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

Policy Options for Livestock-based Livelihoods and Ecosystem Conservation (POLEYC). 2002. Integrated assessment results to support policy decisions in Ngorongoro Conservation Area, Tanzania. Report to the *Global Livestock Collaborative Research Support Program*, University of California, Davis, California, USA.

Policy Options for Livestock-based Livelihoods and Ecosystem Conservation (POLEYC). 2002. Integrated assessment results to support policy decisions in Ngorongoro Conservation Area, Tanzania. Abridged and translated report to the *Global Livestock Collaborative Research Support Program*, University of California, Davis, California, USA.

Runyoro, A.V., K.A. Galvin, P.K. Thornton, S.J. Lynn, and J. Sunderland. In press.

Livelihood strategies: The Maasai pastoralists of Ngorongoro Conservation Area. Proceedings of the Tanzania Wildlife Research Institute Annual Meeting, Arusha Tanzania.

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

## ABSTRACTS AND PRESENTATIONS

Boone, R.B. and N.T. Hobbs. (abstract accepted). Lines around fragments: Effects of fencing on large herbivores. International Rangelands Congress. July 2003.

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

Runyoro A V, Galvin K A, Thornton P K and Lynn S J (2001). Livelihood strategies: the Maasai pastoralists of Ngorongoro Conservation Area. Paper presented at the second Tanzania Wildlife Research Institute (TAWIRI) Annual Meeting, Arusha, 4-6 December 2001.

## PRINCIPAL INVESTIGATORS

**Lead Principal Investigator.** Jim Ellis (October 01 - March 02). Natural Resource Ecology Laboratory, Colorado State University.

**Lead Principal Investigator.** Dave Swift (March 02 - present), Senior Research Scientist, Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, CO 80523. Tel: 970-491-1981; Fax: 970-491-965; Email: davesw@nrel.colostate.edu.