

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

NARRATIVE SUMMARY

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

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

generated from METEOSAT satellite weather data and the AVHRR NDVI greenness data.

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

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

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

RESEARCH

Problem Statement. The recurrent drought and famine, followed by floods are regular features that induce limitations within the natural environment in East Africa. The chances of drought occurring in parts of the Greater Horn have increased from a probability of one in six years to one in three years for areas affected. Repeated occurrences of drought and high variability in precipitation have reduced the ability of many smallholders, such as pastoralists, to maintain their assets or respond when conditions are good. The phenomenon reduces livestock productivity and threatens food security of pastoral communities in the regions. Other natural disasters, such as pest infestations and periodic flooding, destroy area-specific production levels. Migration, as a coping mechanism, can result in conflict/ethnic strife over available resources, such as grazingland and

water. Crisis prevention involves the ability to project emerging conditions and execute actions to prepare for and mitigate, or resolve, crisis and conflict. Effective prevention requires monitoring and analytical capacity at the regional, national and local levels, as well as the ability and desire to respond to warning signs of all kinds. The current set of weather and remote sensing information generated by donor-based monitoring programs (e.g. NOAA RFE, NASA NDVI) offers information on locations of “initiating conditions” while the on-ground monitoring programs of markets, human conditions and animal herd situations reflect, mainly, a “post-effect” appraisal system. However, many of the problems besetting livestock (e.g., weight and body condition loss) have already occurred before the human eye can detect the response. Other human indicators are further down the food chain within the pastoral ecosystem and offer even more delayed post-effect monitoring of emerging crisis. Analysis of these factors supports arguments for a more quantitative early warning system in the region that effectively captures early indicators of emerging drought, especially as it affects livestock throughout the pastoral and mixed farming region of East Africa.

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

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

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

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

The major goal, reflected in the project's approaches, is to mitigate nutritional and social crises for humans in pastoral areas who are dependent on livestock for the majority of their livelihood. The approaches to this goal involve the development of tools and institutional capacity to project impending crisis in livestock nutrition, in East Africa. These approaches are

designed with the intent to quantify emerging negative trends and interject the information into current early warning systems in East Africa to allow more timely decision making and support decision making of early warning systems, donor organizations, NGO, and pastoral CBO under normal and abnormal conditions.

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

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

Progress.

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

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

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

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

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

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

outlook for the monthly IGAD Early Warning Bulletin.

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

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

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

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

Southwest-Central Uganda Zone-Zonal Coordinator Steven Byenkya has established 30 monitoring sites and set up the modeling runs with partial site verification. Mr. Byenkya was awarded a Ph.D. training program by DANIDA and is currently doing coursework at Texas A&M University. He will be returning to the zone in January 2002 and take up his responsibilities as zonal coordinator as he works on his Ph.D. program research. We have worked to build depth in personnel in this zone and it worked fine while Steven was TAMU this past 12 months.

Southern Ethiopia Zone-Zonal coordination for this zone was originally run out of the Adami Tulu site but with the Ph.D. training of Mr. Abule Ebro we had to recruit a new zonal coordinator, Mr. Bayessa Hatewu who is currently in the process of moving his office to Yabello, Ethiopia to run the zone. Mr. Hatewu is seconded by EARO to this site by our national coordinator, Dr. Zinash Seleshi, EARO director of livestock research. Given this disruption in leadership, we have spent a considerable amount of time capacity building for Mr. Hatewu to effectively use and apply the LEWS technology package, requiring two major

site visits by LEWS personnel to get the process moving forward. Currently, there are 18 active sites set up and 12 more sites have been set up and sampled but the model stabilization is pending with anticipated completion in early December 2001. We will add 7 new sites to provide overlap of the PAIRMA project to help support the analysis for the joint PAIRMA-LEWS livestock market analysis component in GL-CRSP. We have commitment of Mr. Hatewu to get these sites characterized in the coming months.

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

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

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

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

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

The NIRS fecal profiling labs are stable in Ethiopia and Kenya and funding secured for the labs in Uganda and Tanzania. DANIDA funded the laboratory and training of personnel (\$85,000). The NIRS equipment has been ordered and it is currently undergoing standardization with the NIRS spectrophotometer at GANLAB at Texas A&M University as well as loaded with the necessary calibration software. We were very fortunate that FAO approved our TCP grant (\$185,000) for establishing a NIRS lab in Dar es Salaam and provide training to lab and field personnel in use of the NIRS/NUTBAL nutritional management system in Tanzania. The

equipment is currently being ordered via FAO-Rome as of this writing. We have also acquired and readied the EARO NIRS machine to be transferred to Ethiopia in the coming months. We are currently arranging training of the EARO staff at Holetta via our lab personnel at ILRI that we originally set up at the start of this project. Copies of Memorandum of Understandings (MOU) with each ministry in Ethiopia, Kenya, Tanzania and Uganda are provided in the appendix of this document.

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

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

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

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

minutes to download our LEWS advisories embedded in the ALIN information that is downloaded as well.

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

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

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

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

was completed with Dr. Wilbur Ottichillo, Director General of RCMRD.

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

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

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

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

pursued as well including SARDEP and ALRMP in Kenya, FARMAFRICA in Ethiopia and the Lutheran World Federation in Uganda. We are finding that NGO's express stronger interest in the LEWS system once they see the steady stream of quantitative information flow into their spheres of influence.

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

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

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

achieve in prediction forage conditions across large regions.

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

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

Recently, Mr. Robert Ford USAID G/EGAD/AFS, Office of Agriculture and Food Security Office, determined that the LEWS geospatial approach should be part of the Geographic Information for Sustainable Development (GISD) program and showcased at the World Summit on Sustainable Development (WSSD) in Johannesburg, South Africa in September 2002. A total of \$45,000 was provided to LEWS to augment our existing program and increase the robustness of our

analysis to insure that we can showcase the full analytical capacity of LEWS at WSSD. The geospatial approach that is being tested with LEWS is emerging as one of the more innovative uses of GIS technology in the development community.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

As stated earlier Dr. Robert Kaitho was given a 90-day training session at Texas A&M University in use of the PHYGROW model, ARCGIS, and GS++ as well as trouble shooting of the LINUX modeling environment. Dr. Kaitho plays a pivotal role in the region as primary technical officer for LEWS based in

Nairobi but working in all the LEWS countries as a technical advisor and liaison to the collaborating agencies, NGOs and donor organizations. We also provided 2-10 day workshops in Nairobi for all the zonal coordinators in LEWS with an intensive 3-day training in geostatistics for Dr. Kaitho and Mr. Raphael Marambii.

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

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

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

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

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

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

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

GENDER

There are two categories of women that are impacted by the LEWS project. The United States and in-country women team scientists and in-country women within the targeted pastoral communities. This past year we had one female research scientist, two female graduate students and one female systems analyst working in the

LEWS project in the USA. Currently, there are seven in-country women team scientists involved in the LEWS program. Two of the female scientists are the country coordinator for LEWS in Ethiopia and Tanzania. Two of the women are zone coordinators and the other two women are site managers. The following are their specific responsibilities, by country.

United States

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

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

Ethiopia

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

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

Tanzania

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

Uganda

Dr. Sarah Ossiya has completed the remaining tasks for the final report of the Coping Mechanism survey jointly conducted by ASARECA and LEWS. The final report was published by ILRI. Dr. Ossiya was leading the efforts to set up a LEWS monitoring zone in North Eastern Uganda, which was delayed by the intensified conflict between the Karamojong and Iteso tribes in the area. Recently, Dr. Ossiya left the National Agricultural Research Organization of Uganda to take a position at the PANOS as a Coordinator of Pastoralist Communication Program, which will cover eight Eastern Africa countries. Dr. Ossiya will be based in PANOS regional office at Uganda.

Dr. Ossiya will continue to work with LEWS as a collaborator since her main mandate is to highlight pastoral issues so that they can be reflected on public agenda targeting both the communities, through radio programs and other media, and the policy makers through advocacy and sensitization.

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

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

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

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

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

Kenya

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

Pastoralist Women

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

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

POLICY

Processes of Institutionalization of LEWS in East Africa

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

- Ministry of Water and Livestock Development
- Selian Agricultural Research Institute,

Arusha

- Animal Disease Research Institute
- Ministry of Agriculture and Food Security Livestock Production Research Institute

ASARECA Crisis Mitigation Office

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

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

The goals of ASARECA CMO Information System are:

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

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

Forming Linkages with other Regional Organizations

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

OUTREACH

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

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

DEVELOPMENTAL IMPACT

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

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

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

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

The technologies assembled and used in this project will be directly transferable to USA grazinglands. The new emerging Grazing Lands Conservation Initiative (GLCI) will be a direct beneficiary since the technology can be directly adopted by NRCS for application nationwide. This should reduce drought and market induced risk to USA livestock producers and improve production efficiencies, all objectives of the new Farm Bill and the Funds for Rural America program. Currently, we are assisting Agrilogic (agricultural insurance analysis company) with the national feasibility study of forage insurance for the ranching industry. Rancher listening sessions have been conducted in 9 regional meetings with the clear consensus that if forage

insurance policies could be written and the LEWS technology used as the quantitative, unbiased trigger mechanism for issuing payments for forage short falls, the industry would support such a system for the USA. A similar approach is being discussed by World Bank for drought insurance feasibility study in Ethiopia. We are making inquiries as to the feasibility to link our work in Ethiopia with this study.

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

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

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

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

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

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

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

LINKAGES AND NETWORKING

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

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

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

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

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

Collaboration with International Research Centers (IARCS) and other CRSPs.

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

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

Because several of our TAMU-LEWS team members are on the global project within the SANREM CRSP, there is strong collaboration between that component and GL-CRSP as it relates to modeling and monitoring technologies. The technical staff working with SANREM CRSP have interacted with the

LEWS team members in Uganda, Kenya and Tanzania as it concerns evaluation of the impact of small holder dairy technology in those regions.

OTHER CONTRIBUTIONS

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

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

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

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

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

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

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

Affairs and Action Contre la Faim (ACF).

LEVERAGE FUNDS AND LINKED PROJECTS

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

Specific grants and funding levels are as follows:

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

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

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

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

FAO-TCP - \$185,000 – “Near Infra-Red

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

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

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

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

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

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

USDA-NRCS - \$190,000 - “National Nutritional Well-being Program for USA using

the NIRS/NUTBAL PRO Nutritional Management System”, This is the 4th year of funding. All technology generated in this program is deployed in LEWS. Funded to Dr. Stuth.

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

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

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

TRAINING

In Progress

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

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

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

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

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

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

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

Completed

Amsalu Sisay, M.Sc, Dec. 1999, Range Science, Alemaya Univ., Dire Dawa, Ethiopia
Sarah Ossiya, Ph.D., August 1999, Range Science, Texas A&M Univ., College Station.

Short term

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

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

An “Advanced Training Workshop on Biophysical Models and Spatial Analysis” was held March 26 – April 3 in Nairobi Kenya. Participants from Kenya included: Peter Wandera, Southern Kenya Zonal Coordinator; Jane Sawe, Egerton University; Benson Wafula; Peter N. Kamau, Egerton University; and William Mnene, Kenya Agricultural Research Institute. Also participating were: Angello Mwilawa, Mpwapwa Agricultural Research Institute; Dr. Nicholas Massawe, Northern

Tanzania; Sarah Ossiya, Namulong Ag. & Animal Research Institute, Uganda; and Negusse Kidane, University of Asmara, Eritrea. Dr. Jerry Stuth, Dr. Robert Kaitho, Mr. Jay Angerer, and Raphael Marambii conducted the training.

COLLABORATING PERSONNEL

United States of America

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

Ethiopia

Azage Tegegne, Animal Scientist, International Livestock Research Institute
Gebre Berhane, Professor, Mekelle University
Abule Ebro, Animal Scientist, Adami Tulu Agri. Research Center
Kassaye Hadgo, FARM Africa, Afar Region
Bayissa Hatwuu, Ethiopian Agricultural

Research Organization
Amsalu Sisay, Animal Production Researcher,
Adami Tulu Agri. Research Center
Dubale Adamsu, FARM Africa, Afar Region
Salvador Fernandez, ILRI- Addis
Tsfaye Kumsa, Institute of Agricultural
Research
Abdissa Abalti, DVM, Adami Tulu Agri.
Research Center
Ashenafi Mengistu, Adami Tulu Agri. Re-
search Center
Dawit Negessa, Lab Technician, ILRI-Debre
Zeit,
Zinash Sileshi, Animal Prod. Researcher,
Ethiopian Agricultural Research Organiza-
tion.

Kenya

Henry Cheruiyot, Director Research Inst,
Kenya Agricultural Research Inst. (KARI)
Philip Leparateg, Drought Preparedness
Intervention and Recovery Program,
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Mahboub Maalim, Aridland Resource Man-
agement Project, Office of the President
Nicholas Georgiadis, Director, Mpala Re-
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Robert Kaitho, SANREM/LEWS/KARI/
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Peter Kamau, Range Animal Scientist,
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Roger Kamidi, Data Analyst, International
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Salim Shaabani, Aridland Resource Manage-
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Aphaxard J.N. Ndathi, KARI, Marsabit

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PUBLICATIONS

- Stuth, J. W. Stuth, Angerer, J. Kaitho, R. Jama, A. and Marambii, R. 2001. Strategies for Monitoring Forage Production as an Indicator of Agricultural Drought. *Agricultural Drought Monitoring Strategies in the World* Kluwer Academic Press.
- Godfrey, R.W. RE Dodson, JK Bultman, DR Tolleson, JW Stuth, and AJ Norman 2001. Use of near infrared reflectance spectroscopy to differentiate pregnancy status and gender of hair sheep in the tropics. *J. Anim. Sci.* 79 (Suppl. I): (in press).
- Angerer, J.P., J.W. Stuth, W.N. Mnene, F.P. Wandera, R.J. Kaitho, and A.A. Jama. 2002. Cokriging of Biophysical Model Output and NDVI to Create Forage Production Maps for Livestock Early Warning Systems. (in press) In: B. Wu (ed) *Proceedings of Landscape Analysis for Rangeland Assessment and Monitoring*, Society of Range Management, Wichita, Kansas.
- Sileshi, Z., A. Ebro, J. Stuth and A. Jama. 2000. Early Warning System and Coping Strategies for pastoralists. Pp. 6-16. *Proc. 8th Ethiopian Society of Animal Production Workshop*. Addis Ababa.
- Andrae, J.G., McCann, M.A., Tolleson, D.R., Bondurant, J., Watson, R., Stuth J.W., and Norman, A.J. 2001. Relationship of clipped diet samples to fecal NIRS diet quality predictions of cattle grazing tall fescue pastures in Georgia. *Journal of Animal Science* 79:28 (Suppl. I)
- Godfrey, R.W., Dodson, R.E., Bultman, J.K., Tolleson, D.R., Stuth, J.W., and Norman, A.J. 2001. Use of near infrared reflectance spectroscopy to differentiate pregnancy status and gender of hair sheep in the tropics. *Journal of Animal Science* 79:26 (Suppl. I)
- Tolleson, D.R., Wilson, T.W., Randel, R.D., Neuendorff, D.A., Lewis, A.W., and Stuth, J.W. 2001. Near infrared reflectance spectroscopy of feces did not reliably predict serum progesterone (P4) in cows. *Journal of Animal Science* 79:21 (Suppl. I)
- Tolleson, D.R., Randel, R.D., Stuth, J.W., Willard, S.T., and Gandy, B.S. 2001. Detection of pregnancy in cattle using near infrared reflectance spectroscopy of feces. *Journal of Animal Science* 79:21 (Suppl. I)
- Tolleson, D.R., Willard, S.T., Gandy B.S., and Stuth, J.W. 2001. Determination of reproductive status in dairy cattle using near infrared reflectance spectroscopy of feces. *Journal of Animal Science* 79:21 (Suppl. I)
- Blaisdell, R.S., Tolleson, D.R., Whisnant, S.G., and Stuth, J.W. 2001. Determination of chemical and biological properties of Blackland Prairie soils in central Texas by near infrared reflectance spectroscopy. *Proceedings: Southern Association of Agricultural Workers meetings*, Ft Worth, TX.
- Tolleson, D., Stuth, J., Vandervorste, W., Steffen, D., Hermann, J., Schmidt, D. 2001. Prediction of weight gain in breeding heifers via the NIRS/NutbalPro system. *Proceedings: Society for Range Management meetings*, Kona, HI
- Tolleson, D., Osborn, R., Neuendorff, D., Greyling, M., Randel, R., Stuth, J., and Ginnett, T. 2001. Determination of gender in four wildlife species by near infrared reflectance spectroscopy of feces. *Proceedings: Texas Chapter, Wildlife Society meetings*, College Station, TX
- Stuth, J.W. and D. Tolleson. 2001. Range management for optimal beef cow fertility. pp. 64-74. In: *Proc. Annual Food Animal Conference: Conception to Parturition: Fertility in Texas Beef Cattle*, June 2-3, 2001, College Vet. Medicine, Texas A&M University, College Station. 126 p
- Ndikumana, J. J. Stuth, R. Kamidi, S. Ossiya, R. Marambii and P. Hamlett. 2000. Coping mechanisms and their efficacy in disaster-prone pastoral systems of the Greater Horn of Africa. *ILRI Press*. Nairobi, Kenya. 112p.

ABSTRACTS AND PRESENTATION

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

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

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

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

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

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

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

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

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

PRINCIPAL INVESTIGATOR

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