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Development of Herder Alliances in the Gobi Region of Mongolia

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GOBI Forage Livestock Early Warning Systems Project

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In 2006, a collaborative pilot project was initiated in Mongolia to test the applicability of developing herder alliances based on the model of North American rural farm and ranch cooperatives. These alliances would be a conduit for the flow of livestock early warning information from the Gobi Forage project, and provide critical services to alliance members. A generic framework for organizing and implementing herder alliances was developed. The Bayanhongor herder alliance was initiated where by electing a board of directors, establishing a constitution, and obtaining status as a legal entity in Mongolia. From this pilot project we learned that: 1) a critical mass of producers is needed to effectively initiate an alliance, 2) an existing infrastructure of technical experts/extension agents is required to raise initial awareness of the alliance and facilitate the recruitment of livestock producers, 3) the initiation of an alliance requires a sponsoring organization to provide startup resources and capital because funds from initial membership shares are not adequate, 4) help is needed from government or NGO organizations to facilitate and connect the alliance to terminal markets and 5) effort is needed to dispel the notion that the herder alliance in only a marketing middleman.

Background

The Mongolian agricultural sector has undergone considerable change during "transition" from the socialist command economy to a market economy. Between 1990 and the present, herders and farmers have had to adapt to top-down driven markets and the loss of inputs and services provided by the state. The incomplete integration of herders and farmers into a privatised, market-driven economy continues to impact the crop and livestock sub-sectors. Drought and severe winter weather cause losses in overall livestock and crop productivity, significantly increase livestock mortalities, and degrade soils that form the agricultural resource base. Livestock production remains primarily an extensively managed, forage based, pastoral production system that is dependent almost solely on forage produced by natural pastureland. Crop production, which is mostly rain-fed, is also subject to and limited by natural factors, especially inadequate precipitation at critical times as well as difficulty in obtaining inputs and services needed for optimal crop production. The risk, both environmental and financial, to which the agricultural producer is subjected, is exacerbated by the lack of suitable response options available to herders and farmers.

A major component of the Gobi Forage Project (GL-CRSP) is developing an information transfer system that allows herders to be forewarned of changing conditions in their pastureland forage base and declining body condition of livestock. This system is patterned after the Livestock Early Warning System (LEWS) developed by the GL-CRSP in East Africa as part of the Famine Early Warning System Network (FEWSNET). Information generated by LEWS on impending drought or declining forage quality conditions that would affect animal productivity or winter survival needs to be delivered to agricultural producers in a timely manner. While Mongolian herders and farmers do need real time information about weather related constraints to crop and livestock production, without the real-time capacity to respond to information about impending drought or severe winter weather, having access to information, in itself, will not enable herders and farmers to avert diminished livestock productivity and mortalities or avert crop failure. Response options in both the public and private sectors must exist for the herder or farmer to productively use the information to respond to unfavourable conditions.

Even with prior warning of adverse weather events, as provided by the Gobi Forage LEWS, livestock herders and farmers presently do not have access to inputs that can mitigate environmental and financial risks inherent in the Mongolian environment. In the livestock sub-sector, lack of access to inputs, especially livestock feed that include forage, hay, and manufactured feeds, is a fundamental constraint to the development and sustainability of the livestock sub-sector. The lack of appropriate and timely access to inputs has an impact on meat quality. With a growing demand for higher quality and "healthy" meat products, the ability to meet market demand is limited. One of the primary

mechanisms for using information and responding to unfavourable conditions is through efficient purchase and sale of stock. The lack of connection to markets represents a major limitation on the ability of herders to respond both to market demand and unfavourable conditions.

Overcoming constraints to agricultural production involves more than access to information. It involves planning and managing agriculture production over at least three time scales: 1) short term, which is immediate or daily, and relates to the day-to-day operation of the enterprise; 2) medium term, which is annual, and relates to the farm crop or animal crop being produced during the immediate production cycle, and 3) long term, which involves herd structure and crop selection to meet future market demand. In the short term, information about impending drought or severe weather will provide little or no benefit to the herders or farmers unless planning to mitigate impacts of the constraint has already occurred and the herders or farmers have the capacity to respond to impending adverse environmental or financial events. Information about drought and weather is most useful to the herder and farmer if medium and long term planning has accounted for these eventualities, and response options exist.

In North America, rural agriculture cooperatives locally owned and operated by shareholders from the agricultural community it serves have been a private sector institution that herders and farmers rely on as a source of inputs, services, marketing, and information. For agricultural cooperatives to be effective, they must be owned and controlled by the membership, and the benefits must accrue to the members (Dunn et al. 2002). The development of a Herder Alliance cooperative was one of the primary activities of the Gobi Forage Project. A pilot Herder Alliance program has been initiated and structured to provide the following: 1) a conduit to transfer risk mitigation information developed by the Gobi Forage LEWS and other sources to herder and farmer members, 2) access to quality production inputs (e.g., veterinary medicines, fertilizer, machinery and equipment, animal feeds, etc.), 3) access to services that will improve product quality or improve producer capacity to engage in agricultural production (e.g., wool and cashmere grading, mechanical shearing, petroleum, spare parts, veterinary medicines, etc.), and 4) direct linkages to markets for crop and livestock off-take products produced by the members of the cooperative (i.e., alleviation of middlemen in the market chain).

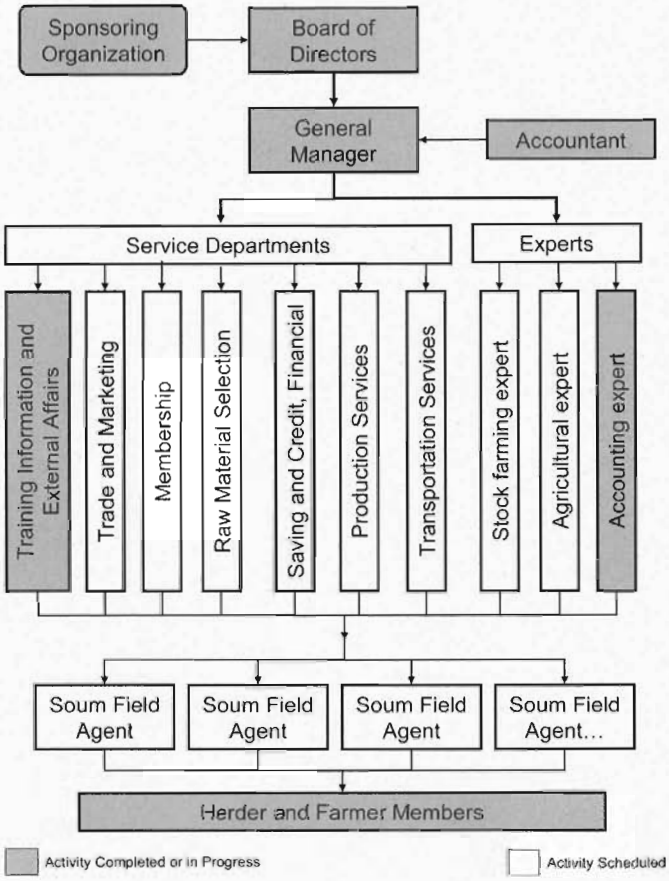
Beginning in 2006, a pilot project, funded jointly by GL-CRSP, USAID-Mongolia, Mercy Corps Mongolia, and the USDA Rural Agribusiness Support Program (USDA-RASP) was initiated in Bayanhongor aimag (province) to test applicability of the Herder Alliance concept under Mongolian conditions and to determine what modifications of the North American rural cooperative model were needed. The GL-CRSP team initiated the Herder Alliance pilot program in 3 soums (districts) within the Bayanhongor aimag. Mercy Corps Mongolia provided logistical support and also assigned two staff specialists from the Gobi Initiative program that had experience in cooperative formation to assist the Gobi Forage team in the implementation of the pilot program.

Preliminary Findings

We sought to develop a generic structure for implementation that could be used by any group who wanted to establish a herder alliance in Mongolia. We began by conducting an informal survey of livestock households/groups to determine if interest and support for a herder alliance existed. This allowed us to define the three pilot areas that were chosen so that we could improve our chances of successful implementation. Once we established the pilot sites in the Bayanhongor aimag, we held organizational meetings to discuss how the herder alliance would work and provided examples from successful cooperatives in the United States. In order for the alliance to be recognized as a business cooperative and as a legal entity in Mongolia, a constitution (i.e., by-laws) and registration with the government as a recognized cooperative was required. The Gobi Forage team facilitated this process and provided examples of constitutions for other cooperatives including some from North America. A constitution was drafted by the Bayanhongor herder alliance and registration was sent to the government. The registration was accepted and the Bayanhongor alliance is now a legal business cooperative in Mongolia. Currently, shares have been sold in the alliance to almost 300 herders. The Board of Directors that consists of 15 members has been elected and includes a chairman and treasurer. A general manager has also been hired, and an office has been opened in the Bayanhongor aimag center.

We developed a general framework for the organization of the Bayahongor alliance (Figure 1) that could be used for additional alliances as they are developed in Mongolia. Under this structure, a sponsoring organization (such as the GL-CRSP or a NGO like Mercy Corps) initiates the development of the alliance and provides initial start-up funds for infrastructure (office space, telephone, computer, etc.) and minimal management staff. The sponsoring organization informs and trains members, directors and management staff about the function of the herder alliance and their duties and responsibilities as specified in the alliance constitution. The sponsoring organization then facilitates the initial meetings of alliance members and oversees the election of a Board of Directors. The Board of Directors are charged with providing the general direction and decision making on behalf of all the alliance members and are responsible for hiring a competent, knowledgeable, and honest general manager and suom field agents.

Figure 1. General framework for organizing and implementing the herder alliance in Mongolia. Shaded areas reflect activities that have been implemented or are in progress at the moment. Non-shaded areas reflect activities that are planned.



The role of the general manager is to develop the service departments of the alliance to assist in providing access to expert services. The soum field officers will be under the general supervision of the alliance manager and be the primary liason between the service departments and the herder and farmer members. For the Bayanhongor alliance, we sought to work toward development of services related to: 1) training information and external affairs, 2) trade and marketing, 3) membership, 4) raw material selection, 5) credit, savings, and other financial services, 6) livestock and crop production services, and 7) transportation (Figure 1). Access to expert services include: 1) stock farming (livestock feedlots and fattening enterprises), 2) general agriculture (crop and forage planting, fodder banking, stocking rate assessment, etc.), and 3) accounting. To date, the training information and external affairs along with access to accounting services have been developed for the Bayanhongor herder alliance.

With the initial launch and establishment of the alliance, time and energy must be invested in building the organizational and institutional capacity of the alliance's board of directors, the manager and the field agents. The board of directors and general manager also need to learn how to manage the alliance, provide transparent information, and be accountable for actions taken, especially in the use of financial resources to all members. The challenge is to build a sense of trust between the members, the board of directors and the general manager and create a general basis of ensuring participation in decision making and day to day management of the alliance.

The major findings of our activity are not necessarily quantitative but reflect qualitative assessments that may be of particular relevance to others who may engage in developing herder cooperatives in Mongolia or in other pastoral regions. First, in order to establish a functioning alliance a critical mass of primary producers must exist that can relate to, and understand the concepts of the alliance. The primary producers need to understand what are the needs and constraints to their livestock businesses, and be able to conceptualize how being a member of an alliance will enable them to access services and information to improve the efficiency and economic viability of their own businesses.

Secondly, for an alliance to be established in a rural area with sparsely populated nomadic livestock producers an infrastructure of technical experts/extension agents must exist that can create awareness of the benefits of group organization amongst the livestock producers. The experts themselves need to have an understanding of the concepts of the Herder Alliance and an ability to relate the concepts to the needs of the rural livestock producers. To achieve this capacity requires an investment of resources and time to train these technical experts/extension agents. Fundamental to the process must be technical experts/ extension agents that believe in the alliance being an organization that can provide solutions to the problems faced by the rural producers.

A third issue is sponsorship. The initiation of an alliance requires capital. In rural Mongolia, liquid capital amongst herders is inadequate for start-up. In order to establish an alliance as a functioning entity and to initiate activities, an initial outlay of capital for office space, communication and initial promotional meetings / training is needed. The costs of a full time general manager for the alliance and the costs of outreach (field) agents in the rural communities also must be subsidized. The management and outreach personnel are key to getting the alliance organized, raising awareness and generating membership interest. The subsidy of general manager and outreach agent fees can be reduced over time once the alliance is fully established and has sufficient members to generate a working capital fund.

A fourth item is related to the perception of alliances as replacement for middlemen. In the Mongolian context of rural livestock production, the middleman is a major player in the market chain for the sale of livestock raw materials including; raw cashmere, wool, skins and hides, meat and processed dairy products such as curds and yogurt. With the establishment of the alliance in Bayanhongor, it has been difficult to communicate that the alliance is more than a replacement of the middleman. Alliances must be seen as more than just a marketing option or as an alternative middleman. For the Bayanhongor alliance and others in Mongolia to be successful, the alliance and its board of directors must clearly explain the role of the alliance and the variety of services that the alliance can provide to its members. The alliance needs to have a very clear understanding of what are the true needs and constraints of rural producers and how becoming a member of the alliance will access to a variety of services that ultimately will increase their efficiency and profits.

Lastly, alliances such as the one in Bayanhongor are located large distances from the major markets with poor infrastructure, bad roads and few options for value added processing in the rural areas. They may require assistance from government and or NGO institutions to develop means to connect them to regional or terminal markets in the major cities. When accessing these new markets, rural producers will need to meet new standards such as contractual requirements, quality control, and timeliness of delivery. Performing appropriately in the new market environments is essential to build trust and long term relationships with the major buyers.

Practical Implications

The development of a supporting infrastructure (i.e. cooperative) that gives livestock and crop producers access to quality production inputs (veterinary medicines, fertilizer, machinery and equipment, animal feeds, etc.), provides and organizes services that will improve product quality or improve producer capacity to engage in commercial agricultural production are practical implications for developing herder alliances in Mongolia. Services such as wool and cashmere grading, mechanical shearing, petroleum, spare parts, veterinary medicines, credit, improved marketing and market access, and regional resource planning can be cultivated and implemented by a herder alliance and therefore improve the livelihoods of it members.

In a situation such as Mongolia where regional resource planning is the mandate of local government, there is a clear role for an alliance to play. At local government levels there is a lack of capacity, technical knowledge, information and outreach to the rural livestock producers for regional resource planning to be organized and effective. An alliance with a large membership base and rural producers that are all commercially minded and view livestock production as more than, "just a way of life" but rather as a "business", the issue of resource management is fundamental. An alliance such as the one in Bayanhongor, with a membership base of 300 members and growing, is well positioned to facilitate the process of resource management, to arrange meetings between producers/members and local government to develop resource planning mechanisms that are appropriate to the situation, and enable environmental resource planning for long-term sustainability.

Further Reading

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The GOBI FORAGE project was initiated in 2004 to adapt Livestock Early Warning System (LEWS) technologies developed by the GL-CRSP in East Africa for Mongolia to improve risk management by herders and other stakeholders in the Gobi Region of Mongolia. The project is a partnership between the Global Livestock CRSP, the USAID-Mongolia Mission, Texas A&M University, Mercy Corps Mongolia, and USDA Rural Agribusiness Support Program, and is managed by Jay Angerer. Email contact: jangerer@cnrit.tamu.edu.

The Global Livestock CRSP is comprised of multidisciplinary, collaborative projects focused on human nutrition, economic growth, environment and policy related to animal agriculture and linked by a global theme of risk in a changing environment. The program is active in West and East Africa, Central Asia and Latin America.

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Design by Susan L. Johnson

GLOBAL LIVESTOCK CRSP

Development Of Portable NIRS Technology To Monitor Grazing Animal Nutrition In Mongolia

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Understanding nutritional status of grazing animals is a critical step in improving livestock productivity in Mongolia. Utilization of near infrared reflectance spectroscopy (NIRS) on feces provides adequate assessment of diet quality, yet initially requires substantial laboratory infrastructure and capacity. The application of portable NIRS in remote settings such as those found in Mongolia shows promise as both a research and management tool, as it allows for rapid assessment of diet quality in the field. Until Mongolian specific calibrations are developed, application of fecal NIRS there is dependent on similarities in fecal chemistry between native and US animals. Fecal chemistry of Mongolian cattle and yak were highly analogous to US cattle, whereas Mongolian sheep and goats exhibited greater differences in fecal chemistry as compared to their US counterparts than did the larger ruminants. Due to these similarities, diet quality from Mongolian ruminant fecal samples can be determined using current US calibrations until either Mongolian specific or Mongolian enhanced calibrations are developed. Fecal NIRS can also be used to discriminate between pairs of sympatric species (i.e. cattle and yak, sheep and goat, horse and khulan). Further development of this discriminant technique will facilitate more efficient collection of samples (by non-livestock oriented individuals), thus expediting nutritional monitoring in large landscapes. Timely assessment of diet quality via fecal NIRS will augment the forage quantity measurements provided by the Gobi Forage project and provide a two-pronged decision support package for pastoralists and agriculture professionals. Portable NIRS yielded results comparable to static NIRS and can thus be used in field conditions. This "take the lab to the sample" approach with portable NIRS can make near-real time, location specific nutritional monitoring available to the herders of Mongolia's vast grazinglands.

Background

Nutritional status of grazing animals results from a combination of forage quantity and quality. NIRS of feces is a non-invasive method by which diet quality can be determined. Fecal NIRS has been employed to monitor the nutritional status of grazing animals in the US and subsequently either extended to or developed independently in other countries. This work was part of the GL-CRSP Livestock Early Warning System (LEWS) project in East Africa. Previous fecal NIRS labs have employed the central lab concept using bench top, static NIRS equipment, i.e. after the US model. In countries with poor travel infrastructure and or mail capabilities, however, the central lab may not always be utilized as effectively for diet quality to be ascertained in a timely fashion. For this reason, a new concept is being applied in Mongolia, namely a "take the lab to the sample" strategy. The recent development and improvement of portable NIRS instruments has provided for the possibility of highly mobile laboratories. The objective of fecal NIRS work in Mongolia is to determine the ability of portable NIRS to monitor diet quality of grazing livestock in remote conditions.

Several questions exist as to the feasibility of applying portable NIRS to fecal samples for determining diet quality of grazing animals in Mongolia.

1. *How well does the portable equipment duplicate the performance of bench top equipment?*
2. *Is the fecal chemistry of Mongolian livestock similar to US livestock?*
3. *Can fecal NIRS calibration equations be developed on portable equipment to predict diet quality of Mongolian livestock?*
4. *What are the logistics associated with delivering portable NIRS to herders in the Mongolian countryside?*

Research projects have been designed to answer these questions. Preliminary results of that research are presented here.

Preliminary Findings

Question 1. How well does the portable equipment duplicate the performance of bench top equipment? Prior to a full scale effort to deploy portable NIRS in Mongolia, the first task was to determine the ability of portable NIRS to predict animal diet quality from fecal samples. The NIR spectrometer is housed at the Grazingland Animal Nutrition (GAN) Lab at Texas A&M University and

Figure 1. Portable NIRS set up for acquiring spectra in the field with hand held fiber optic probe. High Mountain Research Station, Mongolia. Photo by Doug Tolleson

diet quality calibrations developed on this equipment, serve as the "master" system for the LEWS projects. The initial step, prior to even purchasing a portable unit, was to determine the performance of static spectrometer derived calibrations when the spectral range was abbreviated to that of the portable unit. Predictive equations for dietary crude protein (CP) and digestible organic matter (DOM) using the fecal calibration sets for US cattle at 800 to 1700 nm resulted in RSQ and SE calibration (SEC) of 0.81;1.01 and 0.70;1.20 for percent CP and DOM respectively. Once the portable machine was obtained, the first task was to re-create a calibration originally developed on the static machine using spectra collected on the portable.

Near infrared absorbance spectra were collected on the portable spectrometer from a set of 42 sheep fecal samples. Diet reference chemistry values for CP and DOM from the previous study were matched with new spectra obtained on the portable spectrometer. Absorbance spectra from the portable spectrometer are visibly similar to those from the bench-top spectrometer. Predictive equation performance statistics (RSQ;SEC) were: 0.96;0.97, 0.92;0.84 and 0.32;12.3 for CP, DOM and random numbers respectively. Calibration results for the original static NIRS for this set were: 0.95;1.08 and 0.80;1.51 for CP and DOM respectively. Protein results were very similar between the two systems while the portable calibration DOM results were better than the static NIRS calibration.

Question 2. Is fecal chemistry of Mongolian livestock similar to US livestock? The next task was to evaluate the similarity of fecal chemistry between US and Mongolian livestock. Our hypothesis was that there would be enough similarity between the two such that whole scale development of Mongolian specific calibrations would not be necessary. In this case, Mongolian diet reference chemistry:fecal spectrum (D:F) pairs would serve as validations of the US equation performance and as enhancements to the existing calibrations. Fecal samples from cattle, yak, sheep, goats, horses, and khulan or wild ass *(Equus hemionus)* were collected in the Mongolian countryside in 2004 and 2005. These were collected either opportunistically during forage transect work, or specifically during NIRS training excursions. One indicator of spectral relatedness is Mahalanobis distance, basically a multivariate standard deviation. When new samples are evaluated against an existing calibration set spectral population, the Mahalanobis distance of each sample gives an indication of how closely related that sample is to the centroid of the calibration set. The smaller the value, the more spectral similarity to that population. In fecal NIRS calibrations, a value of greater than 8.0 is considered an outlier. US derived calibrations for cattle, sheep, goats and donkeys were used to determine Mahalanobis distance values for each corresponding species. Additionally, yak samples were predicted with the cattle equation and horse samples with the donkey equation. Mean ± SE Mahalanobis distance values for cattle, yak, sheep, goat, horse and khulan were 1.75 ± 0.21, 1.56 ± 0.11, 5.45 ± 1.33, 4.60 ± 0.61, 9.30 ± 0.78, and 13.6 ± 1.34 respectively. Cattle and yak values were well below the outlier determination. Mahalanobis distance values for sheep and goat were greater than the larger ruminants but still within an acceptable range. Fecal chemistry of the equine species, as indicated by NIR spectra, was very different between US and Mongolian animals. These values were well out of the acceptable range. Diet quality from Mongolian ruminant fecal samples can be determined using current US calibrations until either Mongolian specific or Mongolian enhanced calibrations are developed. Current US equine calibrations are not yet sufficiently robust for deployment in Mongolia.

The application of fecal NIRS in extensive landscapes such as those found in Mongolia will depend not only on scientific factors but on logistic ones as well. One difficulty encountered during fecal sampling, specifically by forage transect crews, has been positive identification of the livestock species being sampled. This can be especially difficult within multi-species herds. Sheep and goats for example produce fecal pellets which have a similar appearance. Close observation to visually observe the animal defecating is doable but time consuming. Opportunistic collection would be a more efficient use of time for these crews. An experiment was conducted in Mongolia to determine the ability of fecal NIRS to discriminate between three pairs of livestock or wildlife with similar fecal morphology. These pairs consisted of cattle and yak, sheep and goats, and lastly, horses and khulan. Fecal samples were collected with positive visual species identification throughout the growing season across diverse landscapes in Mongolia in 2004 and 2005. The large ruminant calibration resulted in an RSQ = 0.88 and SE = 0.16. Prediction of species

identity for 16 samples not included in the calibration set yielded 100% correct determinations. Similar values for the small ruminants were 0.66 and 0.28 respectively with 16 out of 20 correct identifications. Corresponding values for the equines, were 0.98 and 0.06 respectively with 12 out of 12 independent validation samples correctly identified. Fecal NIRS can thus be used to discriminate between these pairs of sympatric species. Development of this technique will facilitate more efficient collection of samples (by non-livestock oriented individuals) for nutritional monitoring purposes in large landscapes.

Question 3. Can fecal NIRS calibration equations be developed on portable equipment to predict diet quality of Mongolian livestock? This current project in Mongolia represents the first attempt at developing fecal NIRS diet quality calibrations on portable NIRS equipment. The first step in this process was to conduct small feeding trials to create Mongolian D:F pairs. The trial described here was conducted at the Research Institute for Animal Husbandry (RIAH) headquarters in Ulaan Baatar. Ten mature sheep (40.0 ± 5.0 kg) obtained locally were fed diets composed of Mongolian forages in 2x2 m pens with ad libitum water. Each trial lasted 7 days. Prior to being fed experimental diets, an adaptation trial was conducted in which all animals received the same diet. Afterward, each animal received a unique diet. Each animal took part in more than one feeding trial. Diets were offered at approximately 2% of body weight split into morning and evening feedings. Diet samples, refusals and fecal samples were collected on days 6 and 7 of each trial. Reference data were paired with spectra and used in calibration model development. A total of 63 D:F pairs were created. Due to logistic constraints on applying calibration models with current software for the portable unit, stepwise regression was used to develop diet quality predictive equations. At the time of this writing, DOM was still being conducted on these samples, so only CP will be reported here. Preliminary equation results for diet CP in Mongolian sheep were RSQ = 0.81 and SEC = 1.30. Threshold evaluation criteria for excellent fecal NIRS equations to determine CP are typically RSQ > 0.90 and SEC no greater than 2X the lab error (~ 0.50 in this instance) for the reference method. The values obtained in this calibration set are thus satisfactory, but could be improved. As further feeding trial data are obtained and more refined calibration techniques are applied, it is expected that these results will improve.

Table 1. Portable NIRS predicted values for fecal nitrogen (FN) in sheep and goats.

Sample ID	Date	Species	Herder	Aimag	FN
UGgt.0000001	May 17 2007	Goat	A	Umno Gobi	1.85
UGgt.0000002	May 17 2007	Goat	A	Umno Gobi	1.81
UGgt.0000003	May 17 2007	Goat	A	Umno Gobi	1.89
UGgt.0000004	May 17 2007	Goat	B	Umno Gobi	1.64
UGgt.0000005	May 17 2007	Goat	B	Umno Gobi	1.28
UGgt.0000006	May 17 2007	Goat	B	Umno Gobi	1.64
UGgt.0000007	May 17 2007	Goat	C	Umno Gobi	1.47
UGgt.0000008	May 17 2007	Goat	C	Umno Gobi	1.63
UGgt.0000009	May 17 2007	Goat	C	Umno Gobi	1.55
UGgt.0000010	May 17 2007	Goat	C	Umno Gobi	1.99
UGsh.0000001	May 17 2007	Sheep	A	Umno Gobi	1.53
UGsh.0000002	May 17 2007	Sheep	A	Umno Gobi	1.47
UGsh.0000003	May 17 2007	Sheep	A	Umno Gobi	18.7
UGsh.0000004	May 17 2007	Sheep	B	Umno Gobi	1.81
UGsh.0000005	May 17 2007	Sheep	B	Umno Gobi	1.73
UGsh.0000006	May 17 2007	Sheep	B	Umno Gobi	1.53
UGsh.0000007	May 17 2007	Sheep	C	Umno Gobi	1.82
UGsh.0000008	May 17 2007	Sheep	C	Umno Gobi	1.73
UGsh.0000009	May 17 2007	Sheep	C	Umno Gobi	1.63
UGsh.0000010	May 17 2007	Sheep	C	Umno Gobi	1.58

Question 4. What are the logistics associated with delivering portable NIRS to herders in the Mongolian countryside? The final step in our initial project to determine the feasibility of applying portable NIRS to monitor grazing animal nutrition in Mongolia was to identify and overcome the practical logistical problems one might encounter. Bench-top NIRS is performed under controlled conditions with respect to temperature, light and humidity. There are of course certain environments in which this is more difficult than others, even in a lab setting. In addition to the above mentioned factors, consistent sample presentation could be a problem with the portable equipment. The unit employed in this project utilizes a fiber optic probe which can be handheld (Figure 1) or mounted in a holding apparatus. Our primary goal was to re-create, as closely as possible, the bench-top NIRS laboratory configuration with portable equipment, thus developing and extending new technology.

Initially, only the NIRS equipment itself was moved from place to place. The drying and grinding equipment was established at three RIAH locations: 1) headquarters in Ulaan Baatar, 2) the High Mountain Research Station in Ikhtamir, and 3) the Gobi Research Station in Bulgan. With this suite of test locations established, a route will be evaluated in which the portable NIRS lab will arrive at each facility on a certain day each time period (monthly perhaps).

Fecal samples will be collected from herds in the area on day 1, dried over night, then ground, re-dried and scanned on day 2. Results will then be posted by various means such as print, radio or internet. The portable NIRS equipment has been used in training settings during field trips in 2005 and 2006, however on these occasions, only spectra could be obtained. No calibration equations had been developed nor was there software available to apply equations. In 2007 the combination of appropriate software and a completely Mongolian derived multi-species equation for fecal N allowed the first "road test" of the portable fecal NIRS lab. Twenty fecal samples, 10 each from sheep and goats were collected in Umno Gobi aimag within a 20 km radius of Bulgan. These were dried, ground, scanned and predicted under the conditions encountered on the trip. Notably, electricity was not available in Bulgan at the time with the exception of ~ 8pm to midnight. After several attempts, a portable generator strong enough to power the oven and grinder was located and pressed into service. Fecal N predictions for sheep and goats are presented in Table 1.

Practical Implications

Portable NIRS as applied in this project has several advantages and disadvantages that will affect its practical implementation. On the positive side, portable NIRS equipment is less costly than static systems and can be transported to remote locations for near real-time determinations of grazing animal diet quality. NIRS is a non-invasive and adaptable quantification technique, thus can be applied to a great many substances, not just animal feces. For instance, the technique has been used to sort mohair, from live animals prior to shearing, into fiber diameter groups. Disadvantages of the current configuration primarily involve ensuring adequate electrical power in remote locations to operate the associated drying and grinding equipment. Additionally, the portable NIR spectrometer utilized does not include software capable of developing predictive calibrations. This results in additional software and statistical training for NIRS technicians or creates the need for collaboration with other personnel to obtain the statistical expertise. The full exploitation of NIRS in Mongolia will require establishment of a central static NIRS unit in conjunction with functional wet chemistry laboratories in addition to the portable units. This will allow for both a stable ongoing calibration development environment and a highly mobile, in field, extension of these calibrations. Thus equipped, the Mongolian agricultural scientific community will be able to not only evaluate forages and feedstuffs in an academic setting, but in the realm of grazing animal production as well. By providing samples and feedback on the effectiveness of the portable NIRS technique, herders will be both contributors to and beneficiaries of this new technology.

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The GOBI FORAGE project was initiated in 2004 to adapt Livestock Early Warning System (LEWS) technologies developed by the GL-CRSP in East Africa for Mongolia to improve risk management by herders and other stakeholders in the Gobi Region of Mongolia. The project is a partnership between the Global Livestock CRSP, the USAID-Mongolia Mission, Texas A&M University, Mercy Corps Mongolia, and USDA Rural Agribusiness Support Program, and is managed by Jay Angerer. Email contact: jangerer@cnrit.tamu.edu.

The Global Livestock CRSP is comprised of multidisciplinary, collaborative projects focused on human nutrition, economic growth, environment and policy related to animal agriculture and linked by a global theme of risk in a changing environment. The program is active in West and East Africa, Central Asia and Latin America.

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Design by Susan L. Johnson

GLOBAL LIVESTOCK CRSP

Verification of Simulation Model and Landscape Map Results for Near Real Time Forage Monitoring in the Gobi Region of Mongolia

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GOBI Forage Livestock Early Warning System Project

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Assessment of vegetation productivity on rangelands using conventional methods such as clipping can be very time consuming and expensive, and becomes very impractical to do on a near real time basis. Near real time information is critical for timely decision making in the face of drought and other disasters, especially in the Gobi Region of Mongolia. In this study we sought to assess the ability of a forage simulation model (PHYGROW) to accurately predict forage standing crop at 300 sites, and whether the output from the simulation model could be combined with satellite greenness data to produce landscape maps of forage production on a near real-time basis. The assessment required 3 main steps: 1) model calibration, 2) model validation, and 3) map cross-validation. For model calibration and validation, we found that the PHYGROW model generally did a good job of predicting forage biomass at the monitoring sites with the variability in model predicted biomass to be less than the error associated with actual clipping for biomass production. An assessment of the cross-validation for the landscape maps found a good relationship between forage model biomass and the map interpolated biomass, thus indicating that the forage model outputs can be useful for creating near-real time maps of forage production. These technologies will provide timely information on forage conditions to increase lead time for making risk mitigation decisions by herder groups and policy makers in Mongolia.

Background

The ability to characterize the vegetation productivity over large landscapes can be an important component in the assessment of drought impacts, natural resource management options, environmental degradation, and economic impacts of changing technologies. For pastoralists, an understanding of the vegetation productivity in the surrounding landscape can assist in determining whether to move, buy, or sell animals, and assess the level of risk for decision making. However, the time and resources required to conduct accurate assessments of vegetation productivity over large landscapes are prohibitive, and in many areas such as Mongolia, the infrastructure and funding does not exist to do large-scale characterization. Another complicating factor is that decisions regarding livestock movement and stocking/de-stocking may require near real-time information, especially in the face of drought. Vegetation productivity assessment is almost impossible to conduct over large land areas on a near real-time basis, thus the information needed for livestock related decisions is not always available when it is needed most. The inability to make decisions at critical times could lead to vegetation overuse, which in turn, could lead to environmental degradation.

Improvements in computing power and capacity, along with near real-time production of climate data and remote sensing imagery offer the opportunity to develop near-real time systems for monitoring vegetation on rangelands. Improved computing power and capacity has also increased the use of simulation modeling for agriculture systems, including rangelands. A limitation of many rangeland simulation models is that most provide simulation output for a specific point. Ideally, one would want to simulate as many points (or sites) as possible to represent a region or landscape, especially for the determination of vegetation productivity across the landscape. However, the amount of effort and cost for model parameterization on a large number of monitoring points can be prohibitive. An alternative approach is to conduct simulations for a select number of points and then use geostatistical interpolation methods such as cokriging to create maps of simulation output for a region or landscape (see Stuth et al. 2003; Stuth et al. 2005). These surface maps can then be used represent spatially explicit vegetation production allowing users to monitor conditions and to improve decision making.

As an interpolation method, cokriging can provide estimates for unsampled points using information provided by the cross relationship between a primary variable (in our case, forage model output) and a secondary variable. The secondary variable is usually sampled more frequently and regularly, thus allowing estimation of unsampled points using both variables. Satellite derived vegetation indices (i.e., greenness

indices), most notably the Normalized Difference Vegetation Index (NDVI), have been found to be correlated to vegetation productivity, therefore making this products useful as a secondary variable in cokriging of vegetation productivity.

The assessment of vegetation productivity is especially important in Mongolia where drought and winter disasters (dzud) that deplete vegetation resources represent a major risk confronting herders. During the period from 1999 to 2001, as much as 35% of the nation's livestock was lost to these two disaster events. To help address these challenges to livestock production in Mongolia, a livestock early warning system was implemented with the objective of developing a forage monitoring system that provides near-real time spatial and temporal assessment of current and forecasted forage conditions. As part of this effort, we sought to assess 1) the ability of the PHYGROW forage simulation model to accurately predict standing crop of forage at selected sites across the landscape using the near-real time rainfall data, and 2) the feasibility of using forage model output and NDVI in geostatistical interpolation to produce landscape level maps of forage production.

Major Findings

To assess the ability of the simulation models to produce reliable vegetation productivity estimates as well as the reliability of landscape maps of forage production, we employed a 3 step process. The steps were as follows: 1) model parameterization and calibration, 2) model validation, and 3) map cross validation. Each of these will be described below along with the results of these assessments.

Model parameterization and calibration entailed collection of vegetation composition data to parameterize the PHYGROW model, and measurement of vegetation productivity to calibrate the model. In Mongolia, approximately 300 monitoring sites were established in 8 aimags (provinces) across the Gobi region during the period from May 2004 to October 2006 (Figure 1). At each monitoring site, vegetation composition data were collected along fixed length transects and used to parameterize the model. Vegetation productivity was measured by clipping forage biomass from quadrats of known size and converting the biomass values to kg/ha after air drying and weighing. Calibration of the model for each site involved slight modifications of PHYGROW parameters such as leaf turnover and growth rate to allow the model predictions of biomass to converge at or near the forage biomass measured when the transect was established. For the majority of the monitoring sites, we found a very good correspondence between forage standing crop clipped at the monitoring site and that predicted by the model (R2 = 0.95; Figure 2). However, we had 37 problem sites that we were not able to completely calibrate. We believe these problems may be associated with a mischaracterization of soil at the site, stocking rates that are greater than those reported for the monitoring site, or data collection errors. The majority of these problem sites were located in higher elevation steppe and forest steppe areas, which had high plant diversity and highly variable soils. These sites will require some additional soil sampling to improve our model parameters at these higher elevation areas.

Model validation provides and indication of the calibrated model's performance in predicting the forage biomass without further model adjustments. In subsequent years after transect establishment, the monitoring sites were visited again to collect vegetation productivity data to validate the model output for each site over time. Vegetation productivity was again measured using quadrat methods and the presence/absence of species encountered during the transect establishment were noted. Each site was visited at least once after establishment and some were visited up to 4 times. The results of the validation indicated that the PHYGROW model estimates of forage biomass had reasonable correspondence with that clipped at the monitoring sites (R2 = 0.69; Figure 3). The standard error of prediction for the validation was 83.6 kg/ha which was less than the overall standard error

Figure 1. Location of the monitoring sites within the Gobi Region of Mongolia.

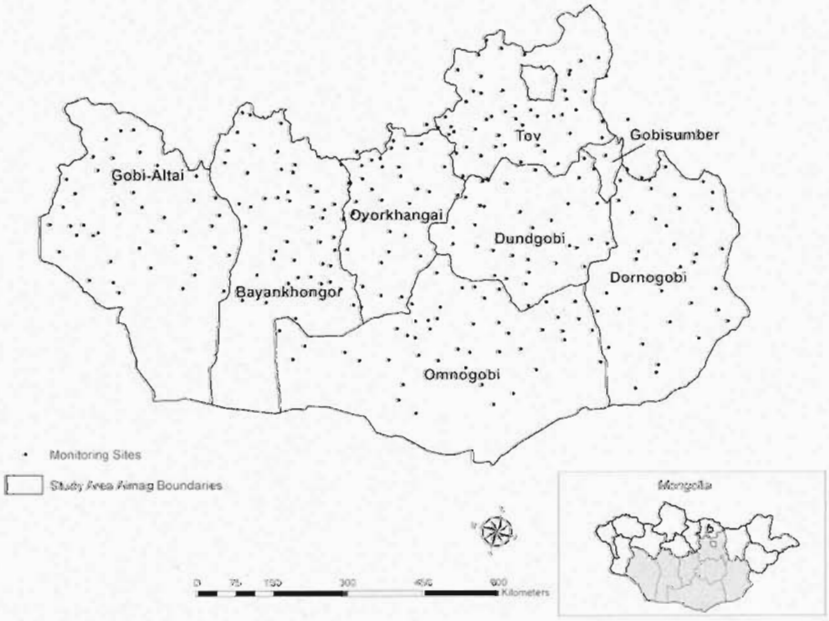


Figure 2. Model Calibration: results of regression analysis of the clipped standing crop versus the PHYGROW forage model standing crop for the first year samples used for calibration of the PHYGROW model at the monitoring sites within the study region.

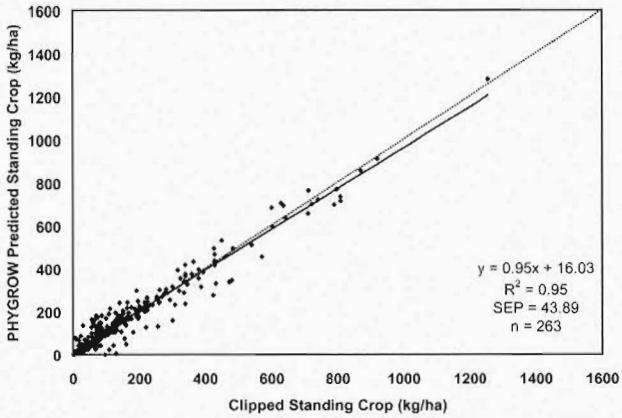
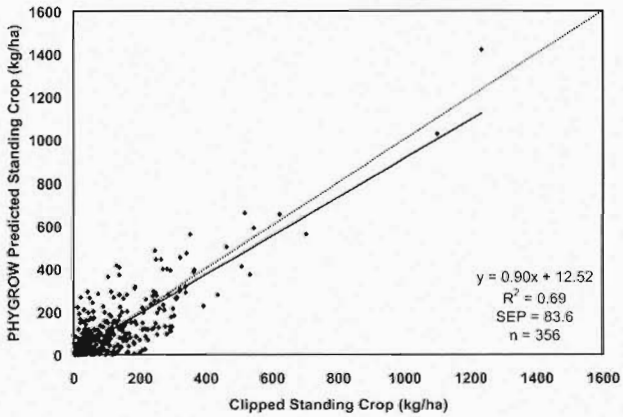


Figure 3. Model Validation: regression analysis of the clipped standing crop versus the PHYGROW forage model standing crop validation sampling at the monitoring sites. Problem sites were removed from this analysis.



associated with the clipping data (115.3 kg/ha) indicating that the variability associated with validation was much less than the variability of the clipping data across all sites.

These validation results provided us with confidence that the calibrated PHYGROW model performed well in predicting forage biomass at the monitoring sites over time. We then used the geostatistical procedure of cokriging (see Isaaks and Srivastava 1989 for a discussion of cokriging) to produce landscape maps of forage production using the model output for each site and satellite greenness (NDVI) data. Satellite greenness data is produced by the National Aeronautic and Space Administration (NASA) every half month. The forage model output was averaged for each half month period to match the production of the NDVI during the growing season (May to September) in 2005 and 2006 when vegetation biomass sampling was conducted in Mongolia. The cokriging procedure not only uses the positive relationship between the forage biomass and the NDVI, but also accounts for spatial autocorrelation (i.e., items closer together in space are generally more similar than those farther apart) to create interpolated maps of forage biomass. To assess how well cokriging predicted forage biomass, we employed a procedure called cross-validation. Cross-validation involves dropping out data for one of the monitoring points and then running the cokriging procedure and predicting the forage value for the point that was left out. This procedure is then repeated for all the monitoring points and then the observed and predicted values can be compared via regression to assess statistically how well the cokriging procedure performs for estimating unsampled points. The results of this exercise indicated that the cokriging procedure generally did a good job of predicting forage biomass (R2 = 0.71). The cokriging procedure had a tendency to slightly overpredict forage biomass and to underpredict forage at higher biomass conditions. The standard error of prediction for cross validation was 111.74 kg/ha which was very similar to that seen for the clipping data (115.3 kg/ha), indicating that the cokriging procedure variability was similar to that encountered with the field clipping data. Like the validation data set, there was a tendency for underprediction of forage biomass in the maps when compared to that predicted by the forage simulation model.

Practical Implications

The results of this study indicate that the use of the PHYGROW forage simulation model would be useful for predicting forage production on a near real-time basis in the Gobi region of Mongolia. The forage model output, when combined with satellite greenness measurements using geostatistics, results in the production of reasonably accurate maps of forage biomass for the Gobi Region. These maps provide both a spatial and temporal assessment of forage conditions that can assist herders, as well as local and regional governments, in decision making for livestock. Since movement of animals is generally the first response of Mongolian herders in times of drought, the regional maps can allow herders to determine areas where they might move their animals or assist them in determining the number of animals they may need to destock. In times of above average forage conditions, this near real-time information can assist in determining the number of animals that the herder could purchase to take advantage of additional forage.

For local and regional governments in Mongolia, the regional maps of forage biomass could assist in determining carrying capacity and stocking rates. During periods of drought/dzud, the maps could be useful in coordinating herder movement to areas where forage amounts are adequate to sustain the additional numbers of animals. At the national level, the maps can indicate "hot spots" where

drought or dzud is most severe, thus providing information to help coordinate disaster relief efforts and pinpoint areas where fodder may need to be delivered.

The collection of data at 300 monitoring sites for model parameterization can become part of a larger database for monitoring rangeland health in region. The transect data collection provides important baseline data to monitor changes in species composition and abundance over time. The use of near-real time forage maps in short term decision making by herders can have long-term benefits to rangeland health if properly used. Timely decision making in the face of drought can reduce environmental degradation and lead to overall improvements in rangeland health and condition.

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Design by Susan L. Johnson

GLOBAL LIVESTOCK CRSP

Technology Transfer Part 1: Implementation of the Livestock Early Warning System in Mongolia

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Gobi Forage Livestock Early Warning System Project

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A series of droughts and winter disasters in Mongolia resulted in discussions between the United States Agency for International Development (USAID) and the Global Livestock CRSP to transfer the GL-CRSP Livestock Early Warning System (LEWS) technology to Mongolia as risk mitigation for these extreme events. LEWS is a forage monitoring system that provides near-real time spatial and temporal assessment of current and forecasted forage conditions, along with an information and communication infrastructure that delivers the information for decision making to herders and other stakeholders. In 2004, the Gobi Forage project was initiated in the Gobi region of Mongolia using the blueprint from the GL-CRSP LEWS implementation, which was initially developed for the east African rangelands. Overall, the transfer of the general technology was successful. However, as would be expected with implementation in a new county and landscape, some protocols, procedures, and data streams had to be modified to accommodate an operational LEWS. For forage quantity monitoring, the infrastructure and protocols developed for East Africa allowed the Gobi team to have a fully operational system within two years; almost two years less than the implementation in East Africa. The general protocols for implementing forage quality monitoring have also been successful, and have resulted in the first in-country use of near infrared reflectance spectroscopy (NIRS) for livestock in Mongolia. In conclusion, the Gobi Forage program provides an example of successful GL-CRSP technology transfer that can be used as a model for other pastoral regions.

Background

During the period from 1999 to 2002, Mongolia experienced a series of droughts and severe winters that lowered livestock numbers by approximately 30% countrywide. In the Gobi region, livestock mortality reached 50% with many households losing entire herds (Siurua & Swift 2002). Due to these extreme losses of livestock and its impacts on pastoral livelihoods, discussions began in early 2003 between the GL-CRSP and the USAID mission in Mongolia to assess the possibility of transferring the Livestock Early Warning System (LEWS) technology developed in East Africa to Mongolia with the ultimate goal of providing timely information on forage conditions to increase lead time for risk mitigation decisions by Mongolian herders. In March 2004, the Gobi Forage project was implemented to apply proven LEWS forage and animal monitoring technology to pastoral communities in the Gobi region of Mongolia (Figure 1, inside page). The objectives of Gobi Forage were similar to those of the East Africa LEWS in that the primary emphasis was to develop a forage monitoring system that provides near-real time spatial and temporal assessment of current and forecasted forage conditions, along with an information and communication infrastructure to deliver the information for decision making to herders and other stakeholders. Under the Gobi Forage program, the transfer of GL-CRSP LEWS technology had three major research activities including: 1) Infusion of forage monitoring technology developed by the GL-CRSP in East Africa to assess regional forage quantity; 2) Infusion of the near infrared reflectance spectroscopy (NIRS) nutritional profiling technology, developed in the USA and refined for early warning in East Africa, to assess livestock diet quality; and 3) Information delivery and outreach.

Gobi Forage represented the first attempt for the transfer of GL-CRSP LEWS technology from one pastoral region to another. The Gobi team began implementation of the Gobi Forage project in May 2004 using the general framework for establishing early warning systems described in Stuth et al. 2003 and Stuth et al. 2005. For the forage monitoring activity, this entailed the establishment of monitoring sites across the Gobi region where plant community information was gathered to parameterize, calibrate, and validate the PHYGROW forage simulation model during the study period. Model outputs were merged with satellite imagery data (Normalized Difference Vegetation Index [NDVI]) to produce landscape maps of forage available to livestock. Model outputs were also subjected to statistical forecasting to predict probable forage conditions out to 60 days. For the forage quality monitoring, this required development and

enhancement of fecal NIRS equations to accommodate the kinds and classes of livestock in Mongolia. Gobi Forge also introduced portable NIRS technology to test whether this type of system would be more useful in Mongolia, due to the poor infrastructure within the country, for sending samples from rural locations.

The objective of this research brief is to provide an assessment of the successes, constraints, and lessons learned through the transfer of GL-CRSP technology developed in East Africa to Mongolia, and how this can be helpful in the transfer of this technology to other regions where drought early warning systems may be needed. Part 1, the current brief, describes the challenges associated with Activities 1 and 2 of the project: the transfer of forage monitoring and NIRS technology for use in the Mongolian version of a LEWS. Part 2 (Angerer et al. 2009) investigates the issues, obstacles, and successes of the Gobi Forage project in delivering the benefits of this transferred technology for use by producers, traders, policy-makers, and development agencies throughout Mongolia, with implications for the use of LEWS technology in rangelands and pastoral areas outside of Asia and East Africa.

Major Findings

Forage Quantity Monitoring

For implementation of the forage quantity monitoring, the Gobi Forage team followed the protocol for establishing the LEWS program that was designed for East Africa. This protocol worked very well and allowed Gobi to establish a set of monitoring sites operational during the second year of the project. The grid computing environment, web servers, software, and mapping procedures developed for East Africa allowed for the seamless integration of the Mongolian data into the system, thus saving approximately two years in development time had this infrastructure not been in place. Despite this rapid progress, however, the team was met with several implementation challenges. The first of these was the lack of unified climate and satellite data sets for use in the near real-time monitoring system. For East Africa, the efforts of USAID's Famine Early Warning System Network (FEWSNET) program have led to the development of a variety of data products that can be used for early warning. The FEWSNET products generally cover all of Africa, are well documented, and are easily accessible. For Mongolia, similar types of products existed, but were not easily accessible, or had not been tested in any type of early warning system. For example, in East Africa LEWS, the National Oceanic and Atmospheric Administration Climate Prediction Center's (NOAA-CPC) Rainfall Estimation (RFE) product is used in the early warning analysis. This product is not available for northern Asia. The Gobi team worked with NOAA-CPC to find a suitable alternative and was granted access to their CMORPH rainfall product. This product is higher resolution than the RFE product and is global; however it had not been tested in Asia, and had not been used for biophysical modeling. During the second year of the project, it was determined that the CMORPH product was over-predicting rainfall, especially in the higher elevation regions of the study area. With the assistance of NOAA-CPC, Gobi Forage was able to develop a bias correction procedure using near real-time rainfall data from stations in Mongolia, China, and Russia, effectively addressing the rainfall concern.

A second challenge encountered in the Gobi LEWS programming was winter disaster monitoring, as this was a protocol not required for LEWS development in East Africa. The Moderate Resolution Imaging Spectroradiometer (MODIS) satellite suite of data products provided Gobi with surface temperature and snow extent imagery along with snow depth imagery provided by NOAA-CPC, to produce products for the winter disaster monitoring component.

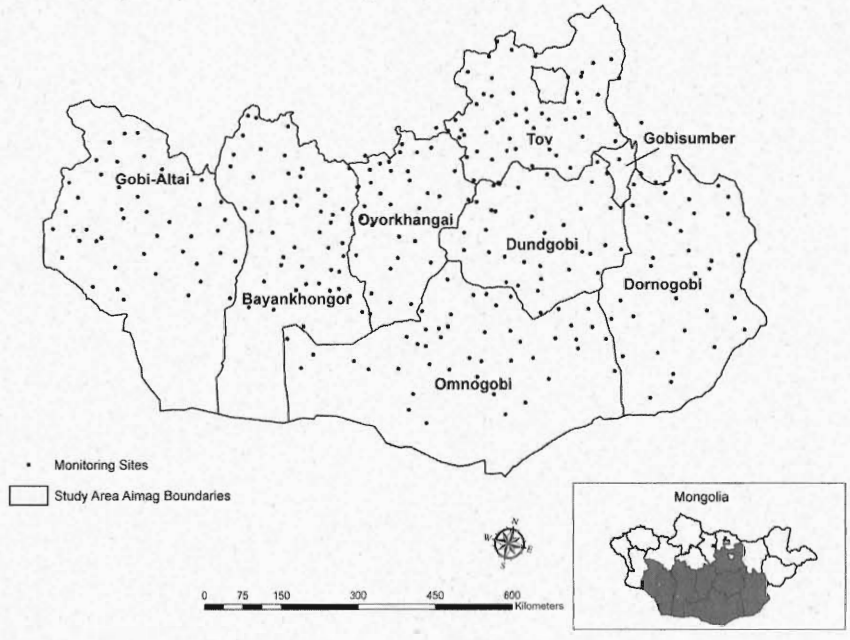
Due to the physical conditions encountered in Mongolia, the Gobi team conducted a more rigorous model and map validation than was done in East Africa. Each monitoring site was visited at least twice during the study period, and some sites were visited up to five times. The short growing season (90 to 120 days) coupled with the first-time use of CMORPH precipitation data necessitated additional ground-truthing. This ground-truthing helped the team to identify problem sites with mischaracterized soils or stocking rates that were higher than reported for the region. Also, once map production began, the additional ground-truthing activities increased confidence among the Gobi Forage team that the forage monitoring technology accurately reflected forage conditions across the region.

Forage Quality Monitoring

For implementation of the forage quality monitoring technology in Mongolia, Gobi Forage adapted the protocols developed in the US and East Africa for establishing a fecal near-infrared reflectance spectroscopy (NIRS) laboratory and livestock nutritional monitoring system (Tolleson et al. 2008). However, because the team introduced new technology with the use of a portable NIRS system suitable for the vast expanse of rangelands encountered by the Gobi team field staff, new protocols had to be developed. These included procedures for sample preparation and equation transfer from the static laboratory machine. Although the portable systems are much cheaper than static laboratory systems (by as much as $25,000 USD), the portable systems do not have the suite of software tools available with the static systems. This resulted in the development of statistical tools to analyze the spectral results and incorporate equations from the NIRS laboratory in the US.

Because of the extreme differences in plant communities between East Africa and Mongolia, Gobi Forage chose not to use the fecal NIRS equations developed in East Africa for initial testing. Instead, the equations developed in the US were used. Initial results indicate that the US fecal NIRS equations did very well at predicting diets of cattle and yaks in Mongolia, but only moderately well for sheep and goats (while still within the acceptable range, i.e. they were not flagged as outliers). The US equation for equines did not fare as well for horses in Mongolia, in that the fecal samples tested indicated they were extreme outliers. As a result of this work, feeding trials were conducted to construct an equine equation for Mongolia, as well as with sheep and goats, in order to improve the small ruminant equations. In addition, since no fecal NIRS equation had been developed for camels in the East Africa LEWS, field observations of diet paired with fecal collections were initiated to develop an equation for camels. The full development of the camel equation, has been hampered by drought in the region where the camel research station is located, and remains incomplete.

Figure 1. Gobi Forage study area and monitoring sites in Mongolia.



For the feeding trials and the housing of the equipment associated with processing fecal NIRS samples, Gobi Forage partnered with the Research Institute of Animal Husbandry (RIAH), a component of the Mongolia Agriculture University. RIAH's mission is basic and applied livestock research and they have laboratories and off-site research centers that allowed the Gobi team to conduct feeding trials for equation development and improvement. This partnership is seen as a critical component for the eventual institutionalization of NIRS technology in Mongolia, a major step for the program's sustainability and success.

The establishment of a NIRS system in Mongolia represented the first in-country use of NIRS technology for livestock. The establishment of this technology in Mongolia has not been as rapid as the implementation of the forage quantity monitoring technology. This is due in part to the education process for introducing complex technology to individuals who have never dealt with any facet of spectral analysis and multivariate statistics. Another constraint is the changing permitting requirements instituted by the US Department of Homeland Security for sending fecal samples from Mongolia to the US for testing and verification on static NIRS equipment. This could be overcome by installation of a static NIRS laboratory in Mongolia. Having both portable and static systems would improve equation development and would potentially have other value-added uses such as fodder, hay, and supplement quality analysis as well as wool and cashmere grading; a critical support network for the long-term management and operation of the system at the national level.

Practical Implications

The Gobi Forage program is a successful example of the transfer of GL-CRSP technology from one pastoral region to another despite divergent climate and ecology. The general framework for implementing the LEWS in East Africa was, for the most part, easily applied to Mongolia. Although the sources and types of remote sensing data for near-real time monitoring of forage were different for Mongolia, the software and system architecture developed for the East Africa LEWS was able to accommodate the inclusion of these data sets with only minor modifications.

The past development of forage quantity monitoring infrastructure for East Africa reduced the amount of time to build a fully operational LEWS by approximately two years in Mongolia. This allowed Gobi Forage to become fully operational by the end of the second year of the project, thus allowing more time to be spent on training and outreach during the third year (see Angerer et al. 2009). The procedures for using MODIS and CMORPH, both global sets of products, will provide additional capabilities should the LEWS technology be transferred to other pastoral regions both within and outside of Asia and East Africa.

The development of portable NIRS nutritional monitoring in Mongolia serves to assist herders in making appropriate decisions for improving nutrition of their animals. As animal fattening enterprises and dairies increase in number to meet the demands for meat and milk in Ulaan Baatar, nutritional monitoring for animals will become increasingly important. The combination of both portable and static NIRS laboratories has the potential to have many value-added services like cashmere grading, milk quality, fodder and hay quality, and soil analysis, and continues to be a long-term goal for Gobi Forage, along with continued improvements in the forage quantity component of the Gobi Forage LEWS.

Further Reading

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Edited by David Wolking and Susan L. Johnson

GLOBAL LIVESTOCK CRSP

Technology Transfer Part 2: The Voice of LEWS: Information Outreach from the Gobi Forage Livestock Early Warning System

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Sean Granville-Ross, Mercy Corps Mongolia;
and Doug Tolleson, University of Arizona
Gobi Forage Livestock Early Warning System Project

Research Brief 09-02-GOBI May 2009

A series of droughts and winter disasters in Mongolia resulted in discussions between the United States Agency for International Development (USAID) and the Global Livestock-CRSP to transfer the GL-CRSP Livestock Early Warning System (LEWS) technology to Mongolia as risk mitigation for these extreme events. LEWS is a forage monitoring system that provides near-real time spatial and temporal assessment of current and forecasted forage conditions, along with an information and communication infrastructure that delivers the information for decision making to herders and other stakeholders. In 2004, the Gobi Forage project was initiated in the Gobi region of Mongolia using the blueprint from the GL-CRSP LEWS implementation, which was initially developed for the east African rangelands. Overall, the transfer of the general technology was successful, with the Gobi Forage team implementing the LEWS and forage quantity monitoring within two years, and forage quality monitoring shortly thereafter. The critical component for the success of Gobi Forage: delivery of LEWS forage quantity and quality information to herders and policy-makers has been most effective using maps delivered by the postal service, along with national radio broadcasts for early warning bulletins, in contrast to World Space Radio and Internet delivery utilized by the LEWS and LINKS projects in East Africa. The information outreach component of the program has been exceedingly well received at the local level, with over 70% of herders and nearly 64% of officials having some degree of familiarity with Gobi Forage products. Although considerable progress could still be made to improve information sharing at the national level, the transfer of LEWS to Mongolia in little over three years demonstrates considerable potential for the long-term impact of the program, as well as a fundamental case study for the benefits of livestock early warning systems in arid rangelands.

Background

During the period from 1999 to 2002, Mongolia experienced a series of droughts and severe winters that lowered livestock numbers by approximately 30% countrywide. In the Gobi region, livestock mortality reached 50% with many households losing entire herds (Siurua & Swift 2002). Due to these extreme losses of livestock and its impacts on pastoral livelihoods, discussions began in early 2003 between the GL-CRSP and the USAID mission in Mongolia to assess the possibility of transferring the Livestock Early Warning System (LEWS) technology developed in East Africa to Mongolia with the ultimate goal of providing timely information on forage conditions to increase lead time for risk mitigation decisions by Mongolian herders. In March 2004, the Gobi Forage project was implemented to apply proven LEWS forage and animal monitoring technology to pastoral communities in the Gobi region of Mongolia. The objectives of Gobi Forage were similar to those of the East Africa LEWS in that the primary emphasis was to develop a forage monitoring system that provides near-real time spatial and temporal assessment of current and forecasted forage conditions, along with an information and communication infrastructure to deliver the information for decision making to herders and other stakeholders. Under the Gobi Forage program, the transfer of GL-CRSP LEWS technology had three major research activities including: 1) Infusion of forage monitoring technology developed by the GL-CRSP in East Africa to assess regional forage quantity; 2) Infusion of the near infrared reflectance spectroscopy (NIRS) nutritional profiling technology, developed in the USA and refined for early warning in East Africa, to assess livestock diet quality; and 3) Information delivery and outreach.

Gobi Forage represented the first attempt for the transfer of GL-CRSP LEWS technology from one pastoral region to another. The Gobi team began implementation of the Gobi Forage project in May 2004. For both the forage quantity and quality components of the program, the Gobi team sought to implement the protocols and methods developed in East Africa for information delivery and outreach.

The objective of this research brief is to provide an assessment of the successes, constraints, and lessons learned through the transfer of GL-CRSP technology developed in East Africa to Mongolia, and how this can be helpful in the transfer of this technology to other regions where drought early warning systems may be

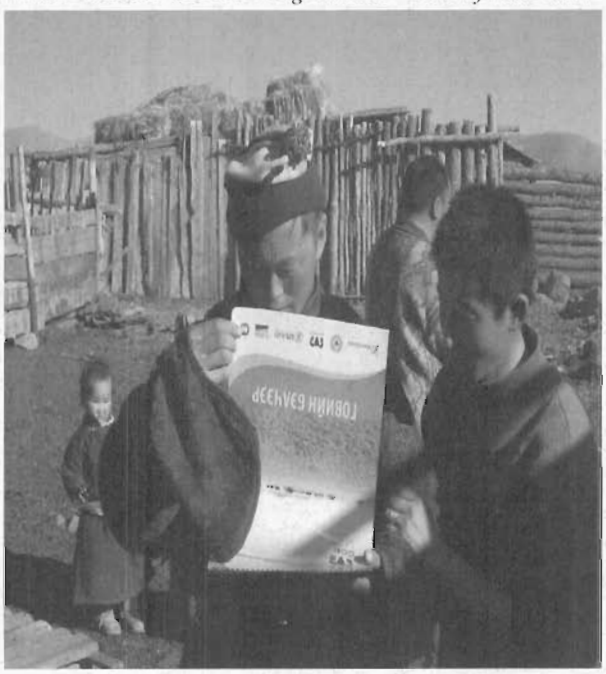
needed. Part 1 of the brief (Angerer et al. 2009) describes the challenges associated with Activities 1 and 2 of the project: the transfer of forage monitoring and NIRS technology for use in the Mongolian version of LEWS. This brief, Part 2, investigates the issues, obstacles, and successes of the Gobi Forage project in delivering the benefits of this transferred technology for use by producers, traders, policy-makers, and development agencies throughout Mongolia, with implications for the use of LEWS technology in rangelands and pastoral areas outside of Asia and East Africa.

Major Findings

Information Delivery and Outreach

The general structure of information delivery for early warning products in Mongolia was similar to that developed in East Africa. The simulation model output for individual monitoring sites along with the 60-day forecast analysis was made available via Internet portal using the same software, databases, and analysis routines developed for the East Africa LEWS. For the map products, Gobi also used the geostatistical software and protocol developed for East Africa LEWS to create the *total forage available* and *deviation from long-term average* maps each half-month. However, delivery of the monitoring site and map information has been quite different in Mongolia. In East Africa, World Space radio download capability and the Internet were used to deliver information to monitoring zones where LEWS collaborators could access the maps and information and deliver it to stakeholders. The incentive to use World Space radios in East Africa is enhanced by the availability of other services such as the Africa Learning Channel. The World Space radio network is available in Mongolia via the AsiaStar satellite; however, the network is rarely used by herders and rural households. Also, there is no additional programming to provide incentives for multiple uses like in East Africa.

A herder examines the Gobi Forage calendar. Photo by Dan Schar.



Internet access is scarce in most of the rural areas of the Gobi Region, although it has improved since the beginning of this study. Despite this improvement, Internet remains an unreliable means of transferring the maps due to the large size of the files and extended download time. Because of these limitations, Gobi Forage chose to use regular postal mail to deliver maps and situation reports to aimag (province) and soum (district) offices, so that the information could be seen by local government personnel as well as displayed on community bulletin boards. Gobi Forage also employed the use of national radio broadcasts to provide situation reports of current and forecast forage conditions. Information on livestock production is provided in these broadcasts, as well as occasional guest speakers to discuss rangeland management and highlight Gobi Forage products. The team has found this to be a very effective communications tool for delivery of Gobi Forage information, and the program has been exceedingly well received at the local level, with over 70% of herders and nearly 64% of officials having some degree of familiarity with Gobi Forage products. Almost all herder households and local/regional government officials have access to radios, and many schedule their activities where they can be near the radio when information on weather and livestock are scheduled during the day. A recent survey in the study region found that 65% of herders considered radio broadcasts as the most useful form of delivery for Gobi Forage information (Figure 1). In a similar survey of local and regional government personnel, the mailed maps were considered the best method for delivery of information (40%) followed by radio bulletins (32%) and the Internet (26%). Current information dissemination plans are to continue to use radio for communication to herder households and to continue delivery of maps for both postal and Internet delivery. Like East Africa, there has been a tremendous increase in the cell phone network in rural regions. The team is currently exploring methodology from the GL-CRSP Livestock Information Network and Knowledge System (LINKS) program for delivering spatially explicit early warning reports via cell phones and Short Message Service (SMS) technology.

As with the East Africa LEWS, the Gobi Forage project developed training programs for herders, government personnel, NGO's and other interested stakeholders in the use and interpretation of the LEWS products. Training in Mongolia was enhanced by the production of a set of DVD videos that were distributed, as well as shown, at the training sessions. These videos proved to be very effective tools for introducing potential users to the Gobi Forage program by providing a description of both the LEWS

methodology and products that are produced. Brochures, calendars, and descriptive maps have also been produced for distribution after training sessions to improve retention of information by trainees.

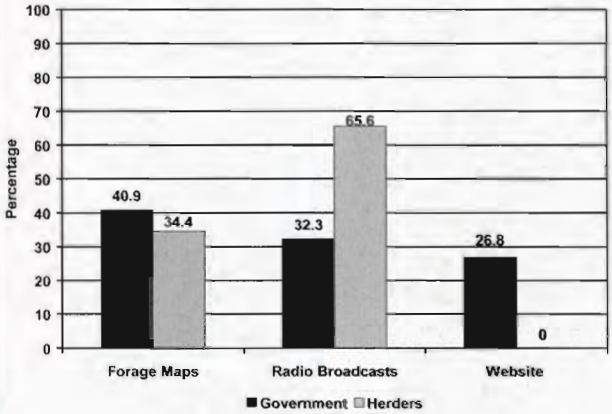
Partnerships, Capacity Building and Institutionalization

An overall major success of the Gobi Forage program was the partnership with USAID's Gobi Initiative that is being implemented by Mercy Corps. The Gobi Initiative is a rural development program designed to assist people in the Gobi region of Mongolia to undertake measures for developing and sustaining market-led economic growth. By partnering Gobi Forage with the Gobi Initiative, Gobi Forage was able to access the Mercy Corps network of program officers and personnel already located within the Gobi region. This was extremely helpful for establishing monitoring sites, implementing training sessions for herders and local government personnel, and receiving feedback on Gobi Forage products. Being located in Mercy Corps offices also provided needed infrastructure for vehicles, office space, and access to a variety of individuals including communication specialists, economists, veterinarians, and other specialists. This collaboration allowed a synergistic relationship to form between Gobi Forage and Gobi Initiative efforts in that the existing network and infrastructure allowed Gobi Forage to become operational in a short amount of time, while Gobi Forage products became an additional service provided to Gobi Initiative participants. The small disadvantage of the relationship was that due to Gobi Initiative efforts focused on herders/ small business, government stakeholders were initially marginalized, and as a result, the Gobi Forage program has had to work hard to establish relationships with the government.

For capacity building of project personnel, Gobi Forage generally followed the same model as implemented in the East Africa LEWS: scientists from the US trained individuals in the host country and host country individuals traveled to the US for short term (4-6 week) training. It was found that having scientists travel from the US to do training in Mongolia was much more effective from a cost, logistical and retention standpoint. By sending US scientists to Mongolia to conduct training, the project was able to train a larger number of individuals, and train them in their own work environment. This reduced distractions and insured that the software and models worked on their machines. For training and study in the US, it was found that Master's level graduate training would probably be more effective than the short-term training.

Like East Africa, the presence of the Gobi Forage project has attracted other groups in the region to provide funding to enhance the LEWS coverage and sets of products. In 2005,

Figure 1. Percentage of the number of government personnel and herder respondents that answered "Yes" to the question of "What is the most useful form of delivery of Gobi Forage Information?" in a survey conducted in October 2007 in the Gobi Forage study area.



funding was received from the World Bank/Netherlands-Mongolia Trust Fund for Environmental Reform (NEMO) Khulan Project to expand the Livestock Early Warning System into the Dornogobi aimag to enhance their study of Khulan (Asiatic Wild Ass) movements and overlap with grazing livestock by herders in the region. This collaboration resulted in an additional 35 monitoring sites and an eastward expansion of the study area (Angerer et al. 2009). In 2006, Gobi Forage received additional funds from the World Bank Sustainable Livelihoods Program to expand the LEWS into the Tuv aimag surrounding Ulaan Baatar, the largest city in Mongolia and the nation's capital. This resulted in the addition of 50 new monitoring sites and expanded the project region northward (see Angerer et al. 2009).

Practical Implications

The success of a technology suite like LEWS with the capacity to forecast drought and other potentially devastating climatic events, and forewarn policy-makers, managers, and herders so that they can take action to mitigate risk associated with these events is fundamentally dependent on the ability of program staff and collaborating partners to deliver the information produced by the technology to those most affected. In little over three years, Gobi Forage has not only managed to integrate East Africa LEWS and forage quality monitoring technology into Mongolia, but also to establish a series of protocols and information delivery systems designed to reach both herders and officials at the local and national levels. In a recent survey and evaluation report conducted on Gobi Forage, "nearly half of herders surveyed reported that they had used Gobi Forage information in the preceding months to guide livestock movements, provide supplementary feed and change their rotational grazing strategy; 35% of these herders reported a net profit resulting from these actions. The overwhelming majority (93%) of government officials

using Gobi Forage products to advise herders indicated that the products were 'very useful for their work.'" While challenges still remain (notably trainings for herders on information interpretation and improved information sharing at the national level), given the time frame, Gobi's outreach activities are considered remarkably efficient.

Furthermore, providing a core set of personnel, infrastructure and funding for LEWS in East Africa and Mongolia has been very beneficial for attracting other donors to fund expansion of the program. This not only has increased the capabilities of the Gobi Forage system, but has provided increased opportunities for the longer term sustainability of the projects. It is this long-term sustainability that is viewed as critical to ensuring continued progress and development of livestock production and management in pastoral rangelands. For long-term sustainability of LEWS technology in both East Africa and Mongolia, institutionalization of these programs within the host countries needs to occur, preferably as part of a government ministry or academic institute that can devote long-term funding for staffing, production, and maintenance of the system. In Mongolia, the funding provided by the GL-CRSP, the USAID Mission, USDA-RASP, and other partners during the last 3.5 years has allowed the LEWS system to become operational in almost half of the country, and has created widespread awareness and use of the products. It remains to be seen, despite the considerable efforts on outreach of the Gobi Forage program, if this length of time has been adequate to create the demand from users (herders, livestock producers, and local, national and regional government officials) for the products to encourage government and/or other donors to provide this funding. Currently, a request for applications has been opened to identify an appropriate institution for housing the Gobi Forage program for long-term sustainability. The authors expect this process to be complete by Spring 2008. *Editors note: at the time of printing, this process remains ongoing.*

Further Reading

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Edited by David Wolking and Susan L. Johnson

GLOBAL LIVESTOCK CRSP

Integrating Information and Communication Technology for the Livestock Early Warning System (LEWS) in East Africa

Jerry Stuth, Robert Kaitho, Jay Angerer, Abdi Jama, William Mnene, Margaret Kingamkono, Joseph Ndungu, Angello Mwilawa, Jane Sawe, Steven Byenkya, Elizabeth Muthiani, Ezekiel Goromela, Clint Heath, Kristen Zander, and Jim Bucher

Research Brief 03-01-LEWS April 2003

The GL-CRSP Livestock Early Warning System project in East Africa has developed a methodology and technology to address the informational needs of pastoral communities relative to changing forage conditions. The LEWS team, led by Texas A&M University in collaboration with a large network of NARS, NGOs, and development agencies in Ethiopia, Kenya, Tanzania, and Uganda, has assembled an integrated suite of technology that provides estimates of livestock forage availability, deviation from normal, and a percentile ranking for a large portion of these four countries. When coupled with a 90-day forecasting system, information such as current forage conditions relative to historical conditions, conditions at the same time during the previous year, and likely forage response in the next 90 days can be provided. Since the human element in complex technology can be a major constraint for deployment in developing countries, LEWS has attempted to devise methods by which data is automatically acquired, analysis is conducted by resident programs scheduled to run unattended, and output information is generated and disseminated to outreach partners in the region. This information is updated every 10 days with situation reports and maps distributed via WorldSpace radios, email, internet, CDs, and newsletters, impacting over 400 organizations and 300 decision makers in the region.

Background

Pastoral communities in East Africa have traditionally relied on historical memory, cloud behavior at given times of the year, atmospheric effects on star brightness, and behavior of plants and animals to develop coping strategies for crisis situations. However, the frequency of drought episodes affecting the Greater Horn of Africa region is increasing as global climatic patterns change. Smaller intervals between drought episodes mean that herders using traditional early warning methods do not have enough time to recover from one drought before the next one strikes. The effects are cumulative and inversely proportional to the length of intervals between episodes. Herders need analytical systems that help interpret changing climatic systems and provide information on emerging forage conditions and likely near-term responses. LEWS has focused on the design and implementation of a new set of technologies that captures weather responses in near real-time and translates that information into forage response over large landscapes in Ethiopia, Kenya, Tanzania, and Uganda. Given the issues of system maintenance and the sparse and inconsistent reporting in pastoral regions of East Africa, the technology suite was developed using remote analysis techniques. When coupled with innovations in communication technology, this suite translates the changing behavior of pastoral forage-based systems into information that can be distributed and interpreted by governmental agencies, NGOs, district officers, and pastoral community organizations.

LEWS Technology Suite

Satellite Weather (RFE/CHARM)

One of the major challenges facing the LEWS program was establishing a basis for capturing daily weather data. Initially, 75 on-site weather stations were established in the project; however, due to theft of equipment, vandalism, and inability to communicate data records in a timely manner to the central analysis site, the LEWS team sought alternative weather data sources. Working with the Famine Early Warning System Network (FEWS NET), we were able to establish an automated link to their METEOSAT-based RFE daily estimates of rainfall and temperature for the entire African continent, updated in near real-time. In order to be able to compute deviation from normal forage conditions, LEWS developed monthly average temperatures and rainfall for the East African countries and used them as coefficients in weather generators parameterized for the nearest World Meteorological Organization (WMO) reporting station. Recently, Funk et al. (2003) reanalyzed historical satellite imagery and released the CHARM rainfall data set containing data from 1961 to 1996. LEWS acquired the CHARM rainfall dataset, linked it with the

generated temperature data, and now uses this data for computing historical forage response and deviation of forage from normal.

PHYGROW Model

The PHYGROW model is the integration tool of the LEWS system. It uses weather and site vegetation information to derive forage conditions that normally would require much time and expense to collect by hand. The model requires input data on soils, plants, livestock density rules, plant preferences by herbivore, and plant growth attributes by species. The LEWS team gathered the necessary soil data for the model. Interviews with local pastoral households provided the stocking density data reflecting their "decision rules" for movement of livestock. Preference values were derived from a combination of researcher opinions and field interviews with experienced herders. Verification of the model indicates that the LEWS technology can predict forage on offer well within field sampling error (see Research Brief 03-03-LEWS).

Satellite Greenness - NDVI

Normalized Difference Vegetation Index (NDVI) provides a measure of green biomass on the ground as seen from the AVHHR satellites. LEWS' automation technology acquires this data every 10 days from the EROS Data Center, which processes it as part of FEWS NET. The greenness data is used in translating the point-based PHYGROW output into maps of forage standing crop and forage deviation from normal. These data are also used in the 90-day forecasting analysis.

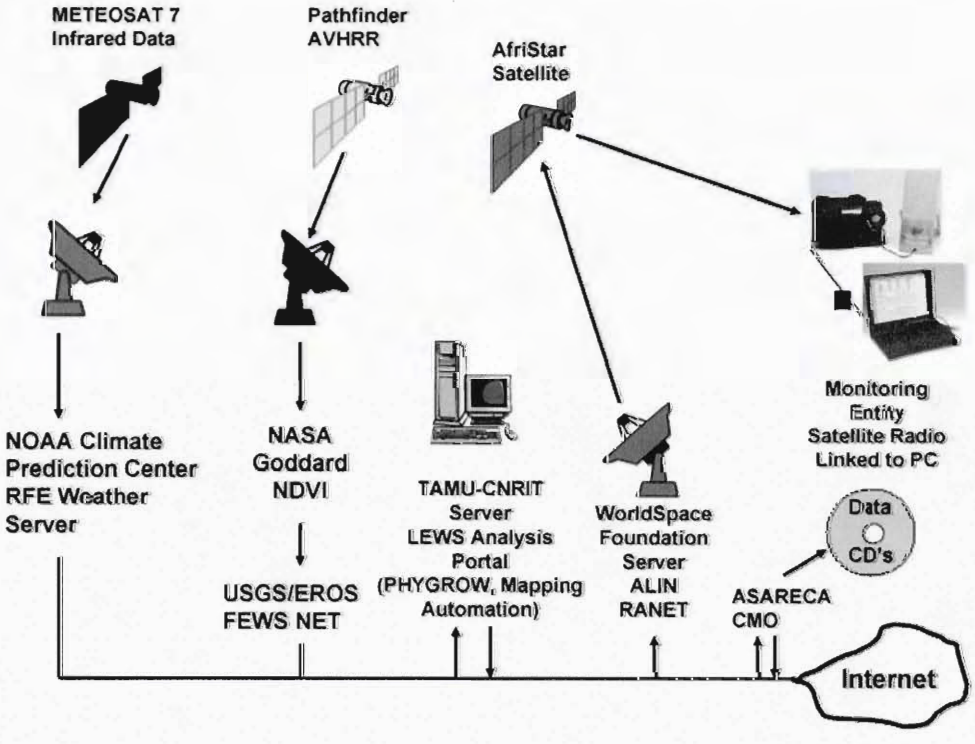
Forecasting Technology

Using the relationship generated by PHYGROW and the CHARM weather data, historically derived forage responses from 1981 to 2002 were coupled with spatially and temporally coherent NDVI data. This coupling allows the LEWS automation system to forecast likely forage conditions up to 90 days in advance with a level of accuracy that is within normal field sampling error (see Research Brief 03-02-LEWS). The forecasting procedure analyzes and projects the data using an AutoRegressive Integrated Moving-Average (ARIMA) model. This approach uses past forage and NDVI conditions along with current forage estimates from the PHYGROW model to predict future grazed standing crop.

Spatial Technology

Mapping of forage supply, deviation from normal forage conditions, and rate of change is conducted using co-kriging between the NDVI data and the point-based PHYGROW analyses. Geostatistics lets us couple biophysical model data collected for a small set of samples in a large landscape with a more spatially rich dataset (NDVI) to interpolate forage responses across a region. For co-kriging to work effectively, a linear relationship must exist between the model forage values and corresponding NDVI data. Since the correspondence between model output and NDVI in co-kriging is spatially dependent, areas where a lack of correspondence exists can be identified, allowing LEWS teams to determine where new sampling points need to be located. Currently, the co-kriging is conducted using

Figure 1: Analytical and communication components of the LEWS system.



commercial software (GS+); however, LEWS is designing an automated mapping system based on GSTAT algorithms that will be deployed in the near future.

Automated Computational Systems

Most of the automation has been completed with the exception of the mapping technology. Human intervention is required to select the best model fit for the co-kriging process. This procedure is currently being researched for eventual automation. The LEWS automation system is located at the Texas A&M University Center for Natural Resource Information Technology (CNRIT). CNRIT has a large on-going program in information technology and therefore provides a minimal cost locale to ensure that the data is acquired, analyzed, and disseminated in a timely manner to all partner organizations in East Africa.

Communications Technology and Outreach

Outreach is critical to the success of the program. Currently, LEWS places all analyses on the Africa Livestock Early Warning System website (http://cnrit.tamu.edu/aflews) with 10 day updates. In addition, subsets of the analyses are automatically reconfigured for broadcast via WorldSpace satellite radios using African Learning Channel bandwidth and containers from the Arid Lands Information Network (ALIN) and RANET. The maps and minimal narrative go to ALIN for distribution in their network of 100+ radios across East Africa. The full situation reports are distributed by RANET in their larger container. Communication nodes established across East Africa involve tuning a $65 USD satellite radio linked to an inexpensive laptop or desktop computer via a signal translator ($35 USD) and transferring the reports at a scheduled time each day. Many of these communication nodes are located in NGO offices, district offices, and communication offices of early warning agencies of each country. The LEWS reports are also emailed by UN-Office for the Coordination of Humanitarian Affairs (OCHA) throughout the region. These reports are condensed versions of the situation reports created by country-level information officers in UN-OCHA. A consortium of FEWS NET, U.S. Geological Survey, World Food Programme, DMC, and LEWS also produces a monthly Greater Horn of Africa Food Security Bulletin. LEWS provides the pastoral outlook report within that bulletin.

Practical Implications

The LEWS technology package demonstrates that satellite weather and NDVI data can be value-added into an analytical system to simulate forage conditions over large regions, map those conditions, and forecast likely responses. This is valuable to multiple-scale decision- makers, such as relief organizations, development NGOs, humanitarian groups, district officers, and pastoral community organizations. The technology translates complex biophysical conditions into timely information that can be transferred through a diverse communication network, from remote NGOs working without electricity to advanced relief organizations with 24/7 internet capacity. More timely and accurate information leads to improved decision-making. Decision-makers can rely on this quantification of data, with a demonstrated consistency in outcome, to formulate decisions that affect the livelihood of pastoral communities. Placing automated information technology in a stable computing environment with very low maintenance needs and linking that output to relevant outreach organizations is a cost-effective mechanism allowing sustained use of advanced technology that maximizes investments on high-impact outreach activities. As institutions in Africa build their human and technical capacity, the system can be mirrored in these institutions and eventually fully transferred. Outreach activities can then be sustained within the existing information infrastructures of these countries without high dependency on maintaining the information technology infrastructure.

Future advances in space-based monitoring technology coupled with new analytical techniques and greater computing power have the potential to vastly improve upon the LEWS technology package. When integrated with other information systems such as those capturing marketing and biosecurity data, the future holds great promise of meeting information needs of developing countries.

Special Acknowledgements

The LEWS project is most grateful to: USGS-EROS for access to NDVI data and the FEWS NET program in East Africa; Tim Love for providing access and assistance in using the METEOSAT RFE weather satellite data; Chris Funk and EROS for assistance in using the CHARM historical satellite rainfall data of Africa; James Nguo of Arid Lands Information Network for being instrumental in establishing our WorldSpace satellite radio mapping reports; Samuel Muchemi of RANET for being instrumental in the deployment of LEWS situation reports within the WorldSpace satellite radio network; Nick Maunder, regional coordinator for FEWS NET of East Africa, for providing leadership in production of the joint Greater Horn of Africa Early Warning Newsletter.

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About the Authors: Dr. Robert Kaitho, Dr. Abdi Jama, and Mr. Jay Angerer are assistant research scientists and Dr. Jerry Stuth is a Kelleher Professor, all in the Department of Rangeland Ecology and Management. William Mnene is a Rangeland Ecologist with the Kenya Agricultural Research Institute-Kiboko. Margaret Kingamkono is an Animal Scientist at the Selian Agricultural Research Institute in Arusha, Tanzania. Joseph Ndungu is a Research Scientist at KARI-Marsabit. Angello Mwilawa is a Livestock Specialist at the Ministry of Water and Livestock Development in Mpwapwa, Tanzania. Jane Sawe is an Assistant Lecturer in Animal Science at Egerton University in Kenya. Steven Byenkya is a Research Scientist in the National Agricultural Research Organization of Uganda. Elizabeth Muthiani is a Research Scientist at the KARI-Kiboko research center. Ezekiel Goromela is a Livestock Research Scientist at the Ministry of Water and Livestock Development in Mpwapwa, Tanzania. Clint Heath, Kristen Zander, and Jim Bucher are systems analysts at Texas A&M University who coded and developed many of the IT tools used in LEWS.

The GL-CRSP Livestock Early Warning System Project (LEWS) was established in 1997 and conducts research, training, and outreach in an effort to provide proactive information on emerging forage conditions and quality to assist pastoralists, NGOs, district officers, and national food security agencies in coping with and mediating emerging drought and rainfall conditions. The project is led by Dr. Jerry W. Stuth, Texas A&M University. Email contact: jwstuth@cnrit.tamu.edu.

The Global Livestock CRSP is comprised of multidisciplinary, collaborative projects focused on human nutrition, economic growth, environment and policy related to animal agriculture and linked by a global theme of risk in a changing environment. The program is active in East Africa, Central Asia and Latin America.

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Design by Susan L. Johnson

GLOBAL LIVESTOCK CRSP

A New System to Forecast Near-Term Forage Conditions for Early Warning Systems in Pastoral Regions of East Africa

Robert Kaitho, Jerry Stuth, Jay Angerer, Abdi Jama, William Mnene, Margaret Kingamkono, Joseph Ndungu, Angello Mwilawa, Jane Sawe, Steven Byenkya, Elizabeth Muthiani, and Ezekiel Goromela

Research Brief 03-02-LEWS April 2003

LEWS has developed a new forage forecasting technology that provides a comprehensive view of emerging forage conditions, as well as 90-day forecasts updated every 10 days. Predicting spatial forage availability will make it possible for pastoralists to assess impending livestock mortality by kind and class of animal and decline in milk production. With the new system, pastoralists will have more flexibility in decision-making, leading to timely de-stocking strategies and an assurance of greater ecosystem integrity. The primary goal of the GL-CRSP Livestock Early Warning System Project (LEWS) is providing pastoral communities and supporting organizations with timely and high-value assessments of emerging forage conditions. Information on current trends in forage on-offer to livestock and the rate of change for conditions across East Africa can be provided by projecting forage conditions from computer models (driven by satellite-based weather data representing points on the ground) and coupling those projections with corresponding NDVI satellite forage greenness data. The forecasting procedure analyzes and projects equally spaced univariate time series data, transfer function data, and intervention data using an AutoRegressive Integrated Moving-Average (ARIMA) model. This approach predicts grazed standing crop of forage in a response time series as a linear combination of its own past values (modeled and NDVI data), past errors (shocks), and current and past values of other time series. Projections of 30, 60, and 90-day forage standing crops resulted in R^2 greater than 0.93, 0.81, and 0.71 with standard errors of prediction of less than 141, 206, and 259 kg/ha of available forage, respectively. This methodology is a powerful new mechanism for decision makers to identify emerging hot spots that may be difficult to perceive, and determine if they are going to recover or worsen with a progressive 90-day analysis window. The forecasts are well within normal sampling error, indicating that this new tool is valuable for predicting near-term forage response.

Background

The Livestock Early Warning System (LEWS) project has been developing a monitoring system to assess emerging trends in forage supply and animal condition on rangelands in Ethiopia, Kenya, Tanzania, and Uganda. Spatial sampling frames are established using climatic clustering techniques overlain with thematic layers for livestock and rural human population densities. Over 300 monitoring sites have been set up in nine zones across the region, covering approximately 50,000 square kilometers, each with minimum of 30 monitoring points. For each geo-referenced monitoring point, a multiple species grazingland plant growth model (PHYGROW) is parameterized with ground-collected data (soil profile, plant community, and grazing rules). The model is then run every ten days with current METEOSAT satellite daily weather data (http://cnrit.tamu.edu/rsg/rainfall/ranfall.cgi) (derived by Xie and Arkin, 1998; Grimes et al.,1999) to determine standing crop of the forage available to grazing animals, and the percent deviation in forage relative to historical weather data (1961-2002). The historical data is based on the CHARM algorithm (Collaborative Historical African Ranfall Model) developed by Funks et al. (2003), corresponding to each monitoring point.

A model that uses both past values of the time series and past shocks is called an AutoRegressive Moving-Average (ARMA) process. An ARMA model of a differenced series is called an ARIMA model, where the I stands for Integrated, because the output needs to be integrated to forecast the original series. As described by SAS (1999), the ARIMA procedure analyzes and forecasts equally spaced univariate time series data using the ARIMA model. An ARIMA model popularized by Box et al. (1994) predicts a value in a response time series as a linear combination of its own past values (autoregressive), past errors, shocks or random disturbances (moving average), and

current and past values of other related time series (covariate).

Both the PHYGROW forage output and Normalized Difference Vegetation Index (NDVI) data were subjected to "white noise" or "prewhitening" analysis, which removed the intrarelationship in the individual series and inherent noise in the data series. This allowed accurate assessment of the interrelationship between the input and the output series. Each data series was then made stationary by applying the appropriate differencing from its ARIMA model. Seasonal dependency patterns were identified, and given the variability in weather patterns over the region. An annual circle produced the best correlation. We removed serial dependency by differencing the series to identify the hidden nature of seasonal dependencies in the series.

The denoised NDVI and forage data was then subjected to the second step of parameter estimation using the function minimization procedure (nonlinear estimation), so that the sum of squared residuals was minimized. The estimates of the parameters were used in the last stage (forecasting) to calculate new values of the series (beyond those included in the input data set) and confidence intervals for those predicted values. The estimation process was performed on transformed (differenced) data. Before the forecasts were generated, the series was integrated (integration is the inverse of differencing) so that the forecasts were expressed in values compatible with the input data.

Preliminary Findings

The ARIMA procedure allows modeling of two correlated time series of data. Figure 1 provides an example of a simple one-to-one relationship between forage standing crop and the satellite-derived NDVI for a given 8 x 8 km grid in East Africa. Given the diversity in landscapes, topography, and vegetation types of East Africa, creation of a spatial and time series data proxy was of paramount importance for developing forecasting capacity in the LEWS project.

The ARIMA time series forecasting methodology appeared to provide suitable projections well within normal field sampling error for most of the 300 sites within the LEWS study region in East Africa. R^2 and SEP (kg/ha) values for 8,820 projections for the 30, 60, and 90-day forecast of grazable standing crop were 0.93/141, 0.81/206, and 0.71/259 respectively (Figure 2).

Practical Implications

Pastoralists, NGO advisors, and government relief agencies have all indicated to the LEWS team that they want to know what current forage conditions are in terms of deviation from historical grazed forage supply, and what those conditions will likely be over the next 90 days, with frequent and timely updates. Prior analysis has indicated that the LEWS technology suite can indeed provide forage condition analyses every 10

Figure 1: Sample relationship between forage and the corresponding normalized difference vegetation index (NDVI).

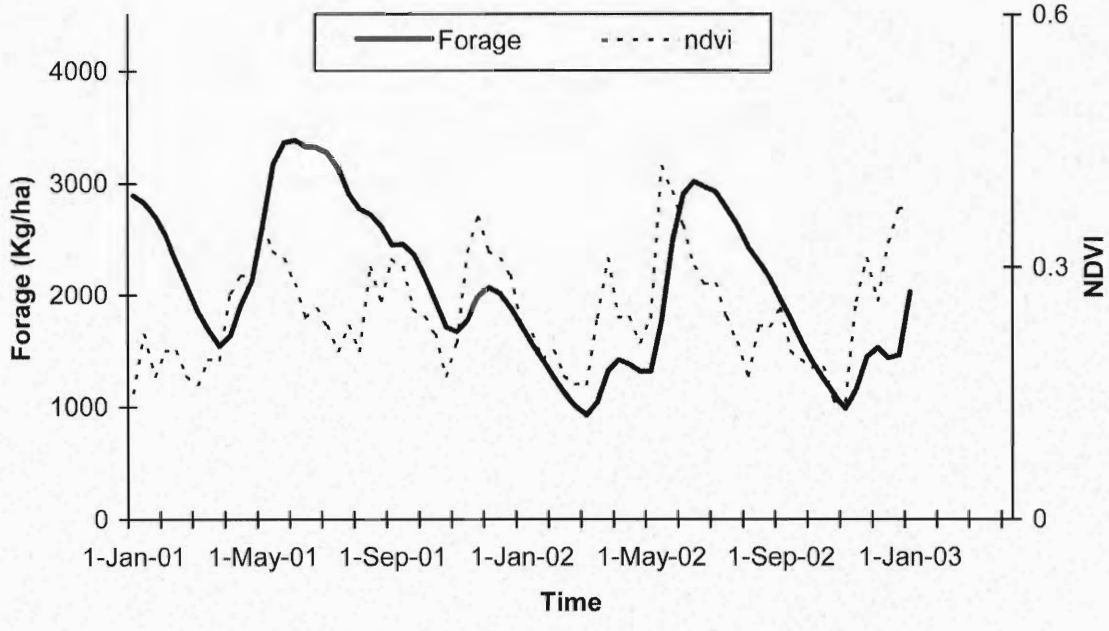
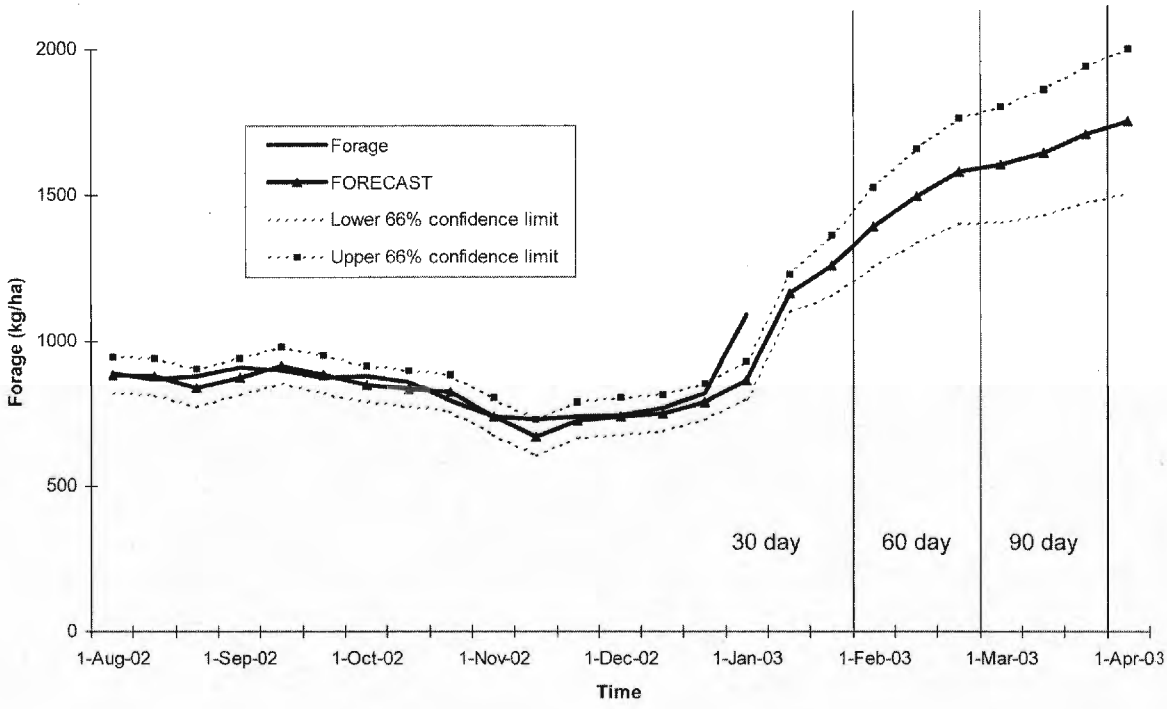


Figure 2: Forage forecast showing 30, 60, and 90-day projections.



days with graphs, maps, and written reports distributed over the Internet and over WorldSpace Radios to over 400 organizations in East Africa (http://cnrit.tamu.edu/aflews). The remaining piece of the puzzle was to provide forecasting information within normal sampling error suitable for decision-making. The analysis conducted herein indicates that near-term forecasting up to 90 days is possible and will provide a valuable additional piece of information to extend the time by which the LEWS information system can have an impact on the decision-making processes concerning livestock management in pastoral communities within East Africa. Our research team continues to work with other forecasting organizations, such as Columbia University's International Research Institute for Climate Prediction to extend our forecasting capacity beyond 90 days.

Special Acknowledgements

The LEWS project is most grateful for the collaboration of USGS EROS and access to NDVI data, and to the FEWS NET program in East Africa. We are also grateful to Tim Love at NOAA's Climate Prediction Center for providing access and assistance on use of the METEOSAT RFE weather satellite data in East Africa. We also acknowledge the contribution of Dr. Marina Vannucci, Assistant Professor, Department of Statistics at Texas A&M University on assistance in application of the ARIMA model.

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Xie, P. and P.A. Arkin. 1998. "Global monthly precipitation estimates from satellite-observed outgoing long wave radiation." *Journal of Climate*, 11(2): 137-164.

http://cnrit.tamu.edu/aflews - Analysis Portal for Livestock Early Warning System for East Africa.

http://cnrit.tamu.edu/rsg/rainfall/rainfall.cgi - Weather Access Portal for African Weather Data Used in the LEWS Program.

About the Authors: Dr. Robert Kaitho, Dr. Abdi Jama, and Mr. Jay Angerer are assistant research scientists and Dr. Jerry Stuth is a Kelleher Professor, all in the Department of Rangeland Ecology and Management. William Mnene is a Rangeland Ecologist with the Kenya Agricultural Research Institute - Kiboko. Margaret Kingamkono is an Animal Scientist at the Selian Agricultural Research Institute in Arusha, Tanzania. Joseph Ndungu is a Research Scientist at KARI - Marsabit. Angello Mwilawa is a Livestock Specialist at the Ministry of Water and Livestock Development in Mpwapwa, Tanzania. Jane Sawe is an Assistant Lecturer in Animal Science at Egerton University in Kenya. Steven Byenkya is a Research Scientist in the National Agricultural Research Organization of Uganda. Elizabeth Muthiani is a Research Scientist at the KARI - Kiboko research center. Ezekiel Goromela is a Livestock Research Scientist at the Ministry of Water and Livestock Development in Mpwapwa, Tanzania.

The GL-CRSP Livestock Early Warning System Project (LEWS) was established in 1998 and conducts research and training in the use of the livestock early warning system, actively monitoring sites in Ethiopia, Kenya, Tanzania, and Uganda. The system detects changes in forage supply and livestock well-being in pastoral regions of East Africa and reports on emerging conditions to both national, international, and community-based early warning and monitoring organizations. The project is led by Dr. Jerry Stuth, Texas A&M University. Email contact: j-stuth@cnrit.tamu.edu.

The Global Livestock CRSP is comprised of multidisciplinary, collaborative projects focused on human nutrition, economic growth, environment and policy related to animal agriculture and linked by a global theme of risk in a changing environment. The program is active in East Africa, Central Asia and Latin America.

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Design by Susan L. Johnson

GLOBAL LIVESTOCK CRSP

A Satellite-Based Technology Predicts Forage Dynamics for Pastoralists

Abdi Jama, Margaret Kingamkono, William Mnene, Joseph Ndungu, Angello Mwilawa, Jane Sawe, Steven Byenkya, Elizabeth Muthiani, Ezekiel Goromela, Robert Kaitho, Jerry Stuth, and Jay Angerer

Research Brief 03-03-LEWS April 2003

The Livestock Early Warning System Project (LEWS) has created a technology suite of products to predict forage conditions on the ground in pastoralist regions of East Africa. The system monitors the impact of emerging weather events on forage supply for livestock. The PHYGROW model is the foundation of the LEWS toolkit. Primary inputs for the model include: soil parameters, plant community characteristics, and livestock management decision rules. These inputs are driven by satellite-based gridded weather data for a particular location, simulating daily forage available for livestock and wildlife. Regular verifications are conducted to ensure that PHYGROW's simulation output of available forage agrees with observations in the field. LEWS scientists sampled 81 of over 300 monitoring sites scattered across Ethiopia, Kenya, Tanzania, and Uganda throughout the entire vegetation production cycles of 2001 and 2002. The zonal teams estimated the total forage standing crop (kg/ha) for 50 plots in each of the 81 grids, based on pre-established reference quadrats. The field data collected by the zonal teams was highly correlated with the simulated model output (R^2 = 0.96 and SEP = 161 kg/ha). The methodology was judged effective in providing large-scale estimates of forage dynamics on the ground, offering a low-cost mechanism for translating weather data into forage over large regions. Satellite-based weather data, coupled with a robust biophysical model like PHYGROW, is a viable base to support early warning efforts in developing countries.

Background

For the past five years, the LEWS project has conducted research and developed a Livestock Early Warning System for the pastoral communities in Ethiopia, Kenya, Tanzania, and Uganda. The project explored an array of technologies and their applications in developing countries, including access to satellite-based weather data and computer simulation models of plant growth and spatial techniques linked with NDVI greenness data. The algorithms needed to derive satellite-based rainfall and temperature data have been extensively tested by Xie and Arking (1998), Grimes et al (1999), and Funk et al. (2003). Similarly, the use of NDVI satellite data has been well established (Tucker et al., 1991). However, the effectiveness of linking the satellite-based weather and NDVI data with PHYGROW, the biophysical model used in the LEWS program, had not been extensively tested in East Africa. The LEWS project found PHYGROW to be an effective model in predicting forage on-offer to livestock over a wide array of East African ecosystems.

PHYGROW is a hydrological-based plant growth model used to simulate daily available forage. The model uses soil parameters, plant community characteristics, livestock movement/destocking decision rules, and weather data for a particular location to simulate daily available forage. The initial characterization of the modal plant communities is based on a sample at a specific location, carefully selected to be as representative as possible of a corresponding 8 x 8 km satellite weather/NDVI grid. The model is run with long-term weather (1961-2002) to test its true stability. During stabilization, a modeler examines both the input and the output parameters for reasonableness and inadvertent errors. Subsequently, the model is placed in a web-based automation process to report daily forage conditions, percentile ranking of forage on-offer, deviations from a long-term average, and projections for the next 90 days on a near real-time basis with minimum human interference (http://cnrit.tamu.edu/aflews). Various geostatistical methods and GIS techniques are employed to produce surface maps of available forage using the point data generated through the automation process. These techniques allow the estimation of forage yield for large areas of non-sampled locations, offering a cost-effective and timely way to monitor forage in vast areas of developing countries.

There are currently over 300 LEWS monitoring points distributed over Ethiopia, Kenya, Tanzania, and Uganda (Figure 1). To set up and parameterize PHYGROW for each of these sites, the host-country scientists led field teams to selected sites representing 8 X 8 km weather and NDVI grids. The teams made 500 observations of basal area of the grasses, frequency of the forbs, and effective canopy cover of the woody species for each site

(Jama et al., 2002). Soils were characterized based on soil surveys (where available) or actual soil sampling at the site. Livestock densities and movement rules were acquired via interviews with local pastoralists using the grid selected as a monitoring site. A minimum of 30 years of daily weather data is needed to drive the model and set up a baseline, or long-term normal, for each site. The weather variables needed are: minimum and maximum temperatures (C), rainfall (cm), and solar radiation (Langley). Baseline weather data was derived from the 1961-1997 CHARM rainfall data set up by Funk et al. (2003) coupled with the RFE/NOAA CPC weather dataset for Africa (1998 to present). Temperature and solar radiation through 1997 were generated by the WXGEN weather generator. For the period of 1998 to present, weather data was acquired at the following sites:

Maximum Temperature
ftp://ftp.ncep.noaa.gov/pub/cpc/fews/daily_gdas_avgs/tmax/
Minimum Temperature
ftp://ftp.ncep.noaa.gov/pub/cpc/fews/daily_gdas_avgs/tmin/
Rainfall
ftp://ftp.ncep.noaa.gov/pub/cpc/fews/newalgo_est/

The resultant PHYGROW model outputs for selected sites were ground-truthed by LEWS zonal teams, based on rapid field appraisal of the standing crop of grazed forage (Haddock and Shaw, 1995). When a test of the PHYGROW model's predicted results indicated a good agreement with the field data, the model was judged both to adequately track the real conditions on the ground and to be eligible for automation. Continuing field verification of model-simulated available forage is an integral part of the Livestock Early Warning System development process. Confidence in model output is necessary to provide credible information to stakeholders and decision-makers.

Preliminary Findings

Over the period of 2001 through 2002, the LEWS zonal teams selected 81 sites across the region for intensive sampling. Fifty 0.5 m^2 quadrats were sampled at each monitoring site using a comparative yield method, where forage biomass is visually estimated on all quadrats using a ranking method. Of the 50 evaluated, 15 quadrats were clipped and used in the development of a regression equation (Haddock and Shaw, 1975). The regression equation is used to convert the rankings into actual forage values. Since PHYGROW estimates grazed forage for each of the target herbivores, only forage available to livestock was measured in the field. The sites were re-sampled if the field sampler's visual estimate and associated clipped samples resulted in R^2 values less than 0.80. More training was provided to the field enumerators having difficulty estimating standing forage values.

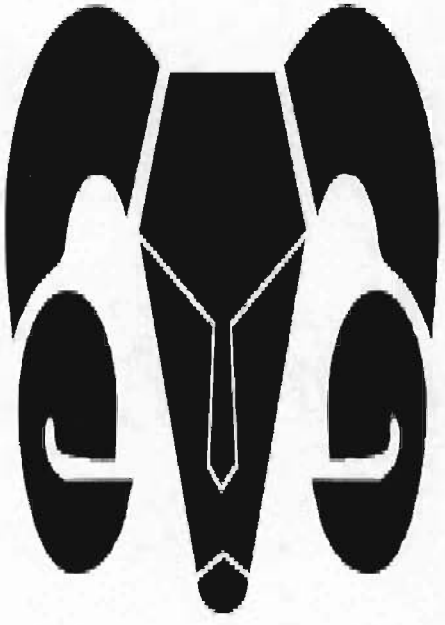

Figure 1: Location of the LEWS monitoring sites and verification sites in East Africa.

Results indicate that PHYGROW accounted for 96% of the observed variation in herbaceous forage on- offer with a standard error of prediction of 161 kg/ha. Mean difference in sampled and predicted forage on-offer was 15 kg/ha. When parameterized properly, the PHYGROW model performed well for the level of analysis required for the LEWS program in East Africa. Committed in-country field staff, trained in LEWS field methodology, was vital to the successful implementation of the model.

Practical Implications

Forage monitoring is becoming increasingly important in East Africa, as frequent recurring droughts affect large areas of the region. Determining forage production over large regions poses a problem of logistics and cost for rangeland monitoring systems in developing countries. This limitation has resulted in reduced capability to determine potential stocking rates for rangelands. Also reduced is the ability to determine the effects of vegetation loss within the context of rangeland monitoring, assessment programs, and livestock early warning systems. The technique of linking the PHYGROW model with satellite-based weather data offers a major breakthrough in establishing a point-based sampling

system of large landscapes. When coupled with rich NDVI satellite imagery, PHYGROW can be used to create maps of forage dynamics in vast and remote regions of the world with limited resource monitoring infrastructure. The resulting methodology is the foundation of the first livestock early warning system applied in East Africa. This system allows pastoral communities, district officers, NGOs, and relief/development decision-makers to be proactive in implementing appropriate management practices or interventions to protect the natural resource base and livelihoods of people using fragile rangelands.

Special Acknowledgements

The LEWS project is most grateful for the collaboration of USGS EROS and access to NDVI data, and to the FEWS NET program in East Africa. We are also grateful to Tim Love at NOAA's Climate Prediction Center for providing access and assistance on use of the METEOSAT RFE weather satellite data in East Africa. Dr. Chris Funk of UC-Santa Barbara and Dr. Guleid Artan were instrumental in supplying our program with the 1961-1997 CHARM rainfall data and supporting literature for Africa.

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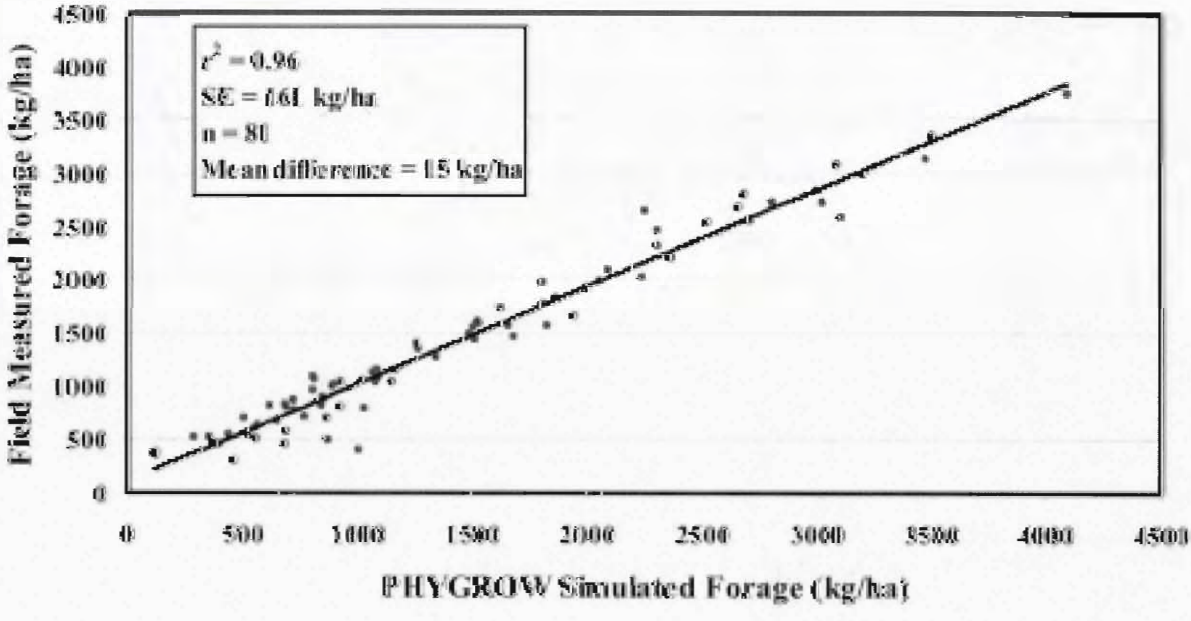
Figure 2: Relationship between sampled standing crop of forage on offer in selected LEWS monitoring sites and available forage predicted by the PHYGROW model.



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The GL-CRSP Livestock Early Warning System Project (LEWS) was established in 1997 and conducts research, training, and outreach in an effort to provide proactive information on emerging forage conditions and quality to assist pastoralists, NGOs, district officers, and national food security agencies in coping and mediating emerging drought and excess rainfall conditions. The project is led by Dr. Jerry W. Stuth, Texas A&M University. Email contact: jwstuth@cnrit.tamu.edu.

The Global Livestock CRSP is comprised of multidisciplinary, collaborative projects focused on human nutrition, economic growth, environment and policy related to animal agriculture and linked by a global theme of risk in a changing environment. The program is active in East Africa, Central Asia and Latin America.

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Design by Susan L. Johnson

GLOBAL LIVESTOCK CRSP

Infusing Nutritional Profiling Technology in Sub-Saharan Africa for Free-Ranging Livestock

Jerry Stuth, Kosi Awuma, Doug Tolleson, Sarah Ossiya, Cyprian Ebong, William Mnene, Angello Mwilawa, Abule Ebro, Steven Byenkya, Abdi Jama, and Robert Kaitho

Research Brief 03-04-LEWS April 2003

A major constraint in determining the relationship between animal performance and the state of pastoral lands in East Africa has been the general lack of nutritional information for free-ranging animals. New technology has been developed that allows the feces of livestock to be scanned with a near infrared reflectance spectrophotometer (NIRS) to predict diet crude protein (CP) and digestible organic matter (DOM). When coupled with the NUTBAL decision support software, which considers diet quality, environmental conditions, forage availability, and feed/metabolic modifiers to predict changes in body weight, this technology package offers resource managers a way to make changes that can improve the herd's overall body condition and mitigate the effects of drought. Five NIRS laboratories were established in Ethiopia (2), Kenya, Tanzania, and Uganda along with trained personnel within the ASARECA AARNET NARS working groups. Validation tests of the NIRS technology indicated that the NIRS system can predict diet CP and DOM within error of standard scientific methodology. The NIRS/NUTBAL system was validated in each of the four countries. Cattle performance of 15 herds representing five breeds and three physiological classes (steers, cows, heifers) was predicted within <3% of body weight, accounting for 93% of variation in the study, and predicting within 5.9 kg of body weight across the population of 105 head. A special solar drier was developed by Egerton University and KARI to ease logistical constraints in pastoral regions. An expanded sub-Saharan African calibration equation was developed for cattle, sheep, and goats based on two Ph.D. dissertations and is currently being combined with calibration sets from the USA, Argentina, Canada, and Australia to form a Global Calibration equation that can be transferred to NIRS labs around the world.

Background

NIRS technology is revolutionizing the way analysis is conducted for a wide array of products. The system allows scanning of material (forage, feces, cosmetics, chemicals, tissue, wool, etc.) with monochromic light and measures the differential absorbance, or reflectivity, of chemical bonds in the target substance in the near infrared band (1100-2500 nm) (Roberts et al., 2003). One can predict the concentration or absence of target variables in samples, based on the combination of sophisticated waveform analysis and calibration sets of known chemical compounds of the target substance. Jerry Stuth, the Principal Investigator of the LEWS team, had developed the methodology in earlier years and desired to test the concept in the context of pastoral lands in East Africa. The initial goal was to provide a monitoring tool to complement the early warning system that simultaneously monitors forage conditions. To ensure that the animal monitoring system was viable for East Africa, a series of technology verification experiments were conducted by NARS partners in Uganda, Ethiopia, Kenya, and Tanzania followed by expansion of the equations with East African vegetation resources for cattle, sheep, and goats.

Methods

Initially, a series of stall-feeding trials were conducted to determine if technology created in the U.S. could predict diet quality from the feces of cattle, sheep, and goats fed mixed rations of native African vegetation. These trials were conducted at ASARECA AARNET research centers in Adami Tulu, Ethiopia (EARO, managed by Abule Ebro), Mbarara, Uganda (NARO, managed by Cyprian Ebong and Steven Byenkya), Kiboko, Kenya (KARI, managed by William Mnene), and Mpwapwa, Tanzania (MLWD, managed by Angello Mwilawa). Concurrently, herds of cattle, sheep, and goats were grazed under normal pastoral conditions at the research centers and the animals' weight and body condition recorded at monthly intervals through one growing and dry season (approximately 6 months). Fecal samples were collected every 14 days, dried, ground, and shipped to Texas A&M University for NIRS scanning. The diet CP and DOM derived from fecal NIRS scans from both the stall-feeding and pastoral grazing trials were predicted with the calibration equation developed for the U.S. Results were put into the NUTBAL metric software, along with animal breed/

sex/age, temperature, humidity, and windspeed. NIRS-predicted CP and DOM values were compared with corresponding wet chemistry values of fed rations. Weights of the animals and predicted weights were contrasted.

After testing the viability of the U.S. system, diet:fecal pairs were gathered from Ethiopia, Niger, and Nigeria by a Ph.D. student (Sarah Ossiya) funded by DANIDA and the Rockefeller Foundation, in collaboration with ILRI animal scientists. Additional sets of stall-fed samples were developed in Ethiopia, Kenya, Tanzania, and Uganda by the ASARECA AARNET NARS network. In addition, a World Bank and Rockefeller Foundation-funded Ph.D. student (Kosi Awuma) was able to work with the LEWS samples and samples collected in Ghana to complete the calibration for sub-Saharan Africa (SSA). These samples were integrated with the sub-tropical samples derived from southern Texas to create a new calibration equation for addressing livestock nutrition in SSA.

Throughout the process of testing and updating the calibration equations, a series of NIRS labs were established. The first, established with ILRI at Debra Zeit in Ethiopia, was a center for training and processing of the samples until the other NIRS labs could be established. Eventually, NIRS laboratories with fully trained staff were established at KARI's research center in Naivasha, Kenya, NARO's research center in Kampala, Uganda, EARO's research center in Holetta, Ethiopia, and the Animal Disease Research Institute in Dar es Salaam, Tanzania. These labs are fully supported by their respective institutions.

Preliminary Findings

When the original U.S. equation was applied to feces of animals on stall-fed diets, crude protein was predicted with accuracy well within standard laboratory error (Cattle $R^2 = 0.80$ and SEp = 0.95; Goats $R^2 = 0.94$ and SEp = 0.72; Sheep (using cattle equation) $R^2 = 0.87$ and SEp = 0.95). However, it was evident that spectral outliers were emerging for high browse diets and for certain growth conditions, requiring possible expansion of the diet:fecal pairs in the calibration datasets.

A metric version of the NUTBAL PRO nutritional balance analyzer software was created and modified to accommodate night penning of animals, which reduces dry matter intake. The CP and DOM values of the free-ranging animals were input in the NUTBAL PRO software, along with the animal and environmental variables to predict weight change and body condition. When the measured end weights were contrasted with the predicted weights in the 15 cattle herds, 93% of the variation in weight was accounted for with an accuracy of +/- 5.9 kg body weight (Figure 1). For cattle and goats, the monthly weights never differed more than 3% of body weight. However, the sheep predictions varied 5-7% of body weight, indicating a need to create a sheep NIRS equation instead of using the cattle equation. Further inspection of the NUTBAL PRO model indicated a need to improve on the efficiency of gain component that was derived from high performance wool producing sheep. These modifications have subsequently been made to the software.

Overall, the series of studies produced CP and DOM equations that predict values well within conventional laboratory methods. When contrasted to studies in Australia, Hungary, the U.S., and Argentina, most the reported standard errors were within or below those reported in referred journals. The results of the field verification and the resulting laboratory calibration equations are practical, simple, and cost effective. The technology could be a powerful tool in the nutritional management of free-ranging livestock in sub-Saharan Africa. Other fecal NIRS studies are currently underway by LEWS to improve the sheep equation, develop a calibration equation for donkeys, and expand the use of the NIRS technology for pregnancy testing, mineral efficiency assessment, and tick stress.

Practical Implications

The NIRS/NUTBAL PRO nutritional management system is a rapid way to assess the nutritional status of the free-ranging animal long before the human eye can detect visible changes in body condition. With the network of NIRS labs in place and NARS scientists trained in the use of the NUTBAL PRO system, the capacity to provide nutritional advisories to pastoral communities is in place. Solar driers developed by the LEWS team at Egerton University allow users to inexpensively (<$35 USD) dry feces on-site, where electricity is non-existent, without affecting the predictive capacity of the NIRS system. Fecal samples can be dried in 48 hours on-site, crumbled into a small paper envelope, and placed on a bus, matatu, transport truck, or express taxi for delivery to NIRS labs in each of the countries with minimal recurring costs to the site monitor/advisors.

LEWS has been working on practical methods of reporting the results back to the advisor without relying on phone, land mail, or fax. One system being investigated involves assigning a site and sample code to a text file that is broadcast several times a week via WorldSpace radios. The NIRS labs have internet connections and can send text files to the WorldSpace radio nodes of advisors in the field via containers of

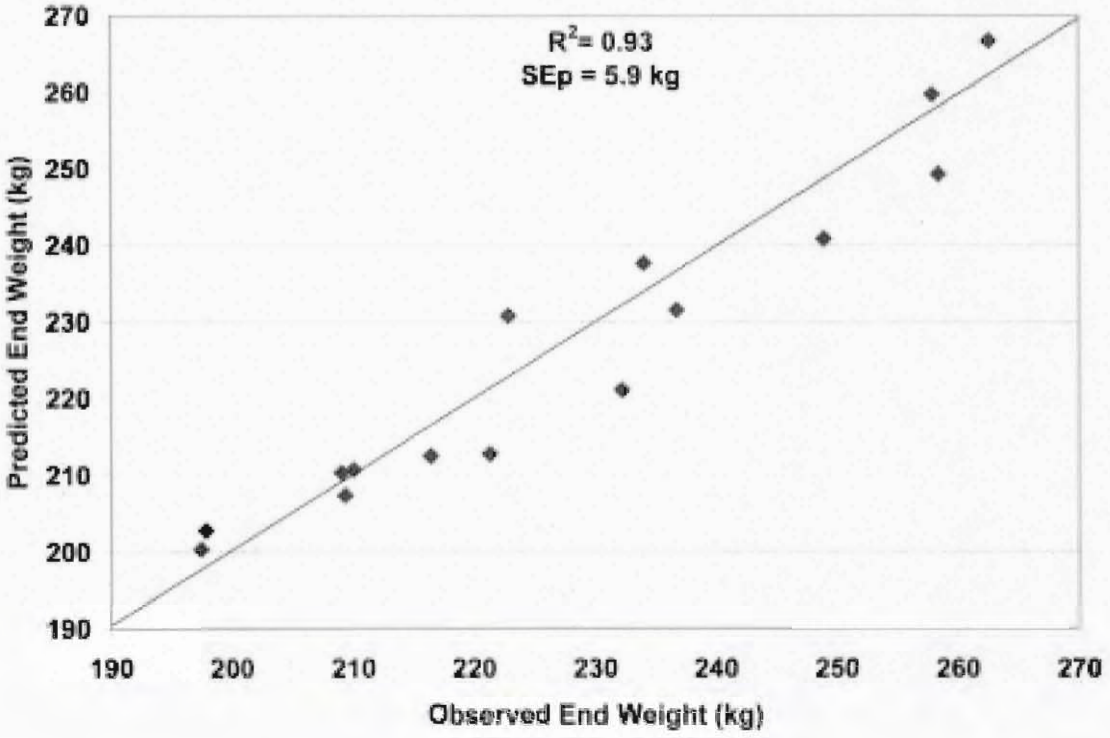

Figure 1: Relationship between predicted end weights using the NIRS/NUTBAL technology and actual end weights of 15 herds of cattle grazing rangelands in four countries of East Africa.

LEWS collaborating institutions (Arid Lands Information Network, RANET). This method requires a satellite radio, converter, and cheap laptop, about $800-$1000 USD per node. The other method involves use of SMS text messaging on cell phones, where advisors in areas with cell phone capacity are provided with the phones and code system. The NIRS lab then transmits the SMS text message of sample number, date, CP, and DOM value at a cost of $.01/sample, plus the initial cost of the cell phone. Both techniques require a 2-day training session for the NUTBAL PRO software, and use of the satellite radios or SMS cell phone.

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The GL-CRSP Livestock Early Warning System Project (LEWS) was established in 1998 and conducts research and training in the use of the livestock early warning system, actively monitoring sites in Uganda, Tanzania, Kenya, and Ethiopia. The system detects changes in forage supply and livestock well-being in pastoral regions of East Africa and reports on emerging conditions to both national, international, and community-based early warning and monitoring organizations. The project is led by Dr. Jerry Stuth, Texas A&M Univrsity. Email contact: j-stuth@tamu.edu.

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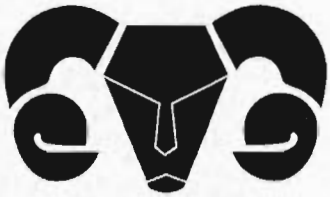
Design by Susan L. Johnson

GLOBAL LIVESTOCK CRSP



Application of Information Communication Technology in Developing a National Livestock Marketing Information System: The Case of Kenya

Gatarwa Kariuki and Robert Kaitho
Livestock Information Network and Knowledge System (LINKS) Project

Research Brief 06-01-LINKS August 2006

Marketing remains one of the greatest challenges in the development of the livestock industry in Kenya. In spite of the emergence of organized market intelligence particularly in relation to prices at terminal markets, the lack of and need for price information in many of the pastoral areas remains a critical concern by producers, traders and policy makers. The Livestock Information Network and Knowledge System of the Global Livestock Collaborative Research Support Program has responded to this need by developing a livestock marketing information system based on information communication technology that has now been adopted as the basis for developing a national livestock marketing information system for Kenya. The development, testing, implementation and expansion of the system have all been made possible through collaboration among different stakeholders with interest in livestock marketing information. It is expected that provision of such information and improvement of the capacity to communicate the same will have a positive effect on market transactions in terms of improving sales and identifying markets offering better prices.

Background

It is estimated that livestock contributes upwards of 10% and about 25% to Kenya's GDP (of US$ 10.1 million) and agriculture sector respectively. Most of the livestock is produced in the pastoral system and marketed from the arid and semi-arid areas of Kenya which account for about 8% of the country's population and occupy roughly 63% of the total land area (Narman, 1990; Republic of Kenya, 1994). The pastoral production system is one that essentially derives from the exploitation of forage and water to maintain and increase livestock inventory. The system is primarily geared towards meeting the subsistence needs of the pastoralists by providing the major ingredients of their diets and for enhancing social relationships. However livestock has acquired a niche in the national, regional and global livestock trading chains and livestock producers are part of the commercial webs of trade relationships among people and countries in different locales (Kariuki, 2001). In spite of its importance and contribution to the national economy, the development of the livestock industry has faced numerous challenges. Livestock producing areas and by extension livestock producers have to contend with shocks emanating from a host of factors including threats of droughts, poor marketing and communication infrastructure, disease outbreaks, insecurity, and a policy environment that lacks effective institutional support to production and marketing of livestock and livestock products as commodities for trade. The lack of a transparent, timely, and efficient livestock marketing infrastructure is recognized as a major factor hindering the improvement of gains to livestock trade in order to benefit the national economy through derived taxes and more importantly perhaps to benefit the communities of livestock producers (Aklilu, 2002; GL CRSP, 2003). A reliable livestock market information system is a key element in supporting decision-making of other players such as traders, middlemen and policy makers and contributes to the development of pastoral areas (Barrett and Luseno, 2001; Kaitho et al 2004). Provision of marketing information or the improvement of the capacity to communicate the same will have a positive effect on market transactions in terms of improving sales and identifying markets offering better prices, identifying market hot spots and where to source for animals that meet expected quality and health standards for local and international markets. It is against this background that the Livestock Information Network and Knowledge System (LINKS) project of the Global Livestock Collaborative Research Support Program (GL CRSP) initiated a livestock marketing information system geared towards addressing the needs for timely and reliable information for producers, traders and policy makers in the sub-sector.

History and Evolution - From LEWS to LINKS

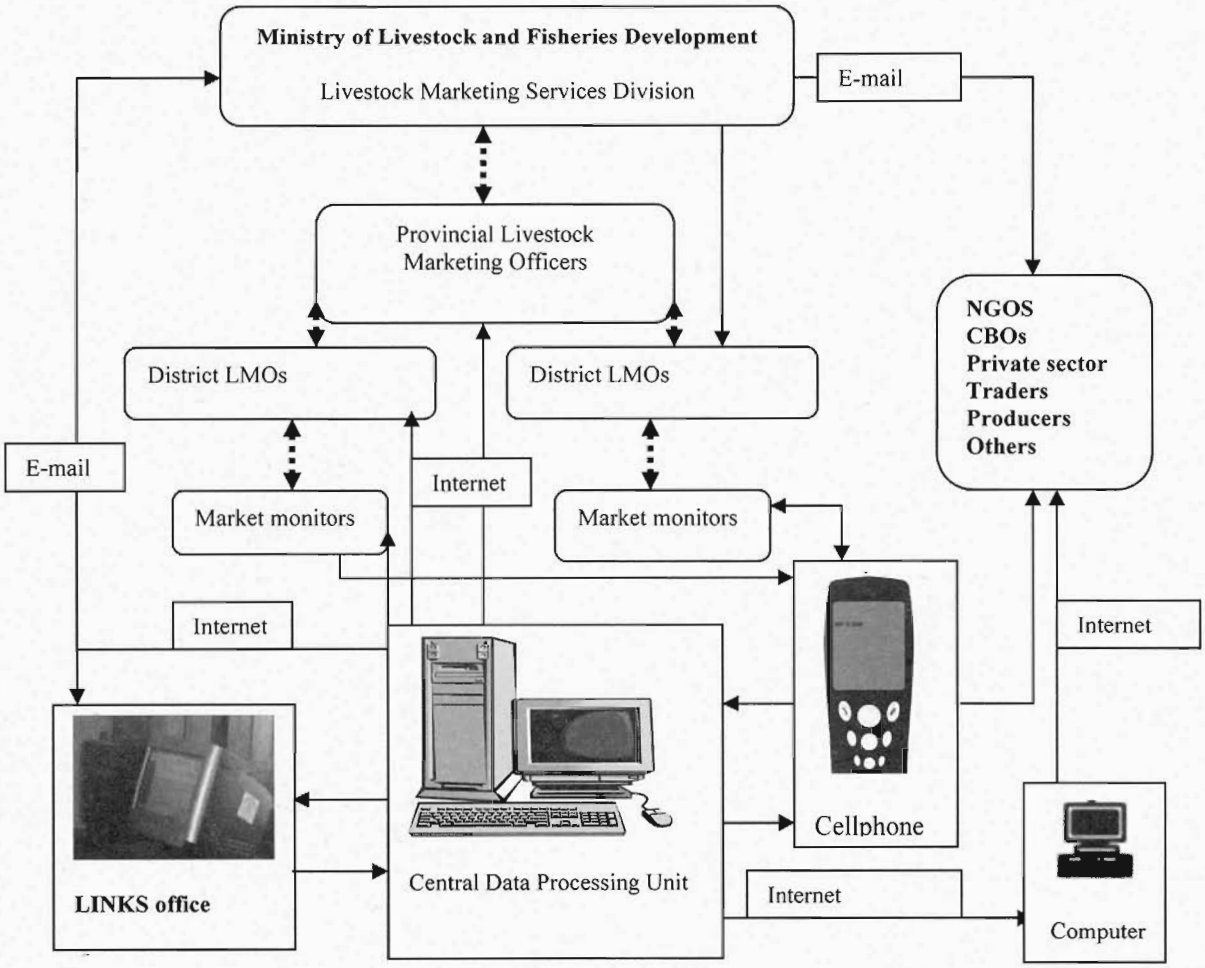
In 1997 the GL-CRSP implemented the Livestock Early Warning System (LEWS) for eastern Africa project which culminated in the development of spatial models for assessing and forecasting forage situation as the basis for providing early warning information for livestock-based production systems. Through a collaboration with the GL-CRSP Pastoral Risk Management (PARIMA) project, LEWS scientists recognized the need to place

LEWS technology inside a broader livestock information and analysis system that is designed to improve livestock markets and trade. In 2003, the LEWS project evolved into the LINKS project but continues to generate the early warning information updated every ten days and used to produce advisories usable by agencies and communities of livestock producers. The core program of LINKS focuses on information technology development, establishing communications infrastructure and technology, identifying and developing working relationships with key livestock marketing authorities, agencies and livestock marketing associations in Kenya, acquiring livestock market information to support the need for market information and modelling analysis as well as design of potential output products and delivery systems.

National Livestock Marketing Information System and its Accomplishments

LINKS has responded to the livestock marketing information needs by designing an information communication technology infrastructure for reporting and requesting information on livestock sales and prices from a network of different markets in Kenya. In partnership with other collaborators, LINKS has been integrated into a livestock marketing information system that facilitates dissemination of information so as to reach end users in the remote livestock producing areas. The idea of integrating the system into the activities of the livestock sub-sector was shared with stakeholders in the sector who, after collective evaluation, agreed to adopt the system for developing a National Livestock Marketing Information System (NLMIS) to cover as many nodes as possible in the network of key and remote livestock markets in Kenya. The objectives of the NLMIS are to avail information through various media to all players in livestock marketing, establish a livestock marketing database for reference in planning, research and monitoring of marketing trends, and to provide early warning information for disaster preparedness. The activities to achieve these include training of field data collectors in the techniques of data collection and reporting and train all stakeholders on the interpretation and use of information available from the NLMIS. There is also training on how to download, analyze and summarize the information for transmission to end users in a form that fits their requirements.

Figure 1. The system is designed to report and disseminate information based on the following model.



The NLMIS is run by a committee drawing its members from stakeholders with interest in livestock marketing information and a technical arm headed by the Livestock Marketing Services Division of the Ministry of Livestock and Fisheries Development. The division is charged with coordination and administration of the system among the network of livestock marketing officers and data monitors. The District livestock marketing officers supervise data collection and reporting to ensure consistency, accuracy, and timely reporting by the data monitors and also keep custody of the hard copies of the data sheets. The data monitors code the data to text messages that they send via cellphones to the central data unit which processes the incoming data, decodes it and submits the output into a central database (http://www.lmiske.net). Using a pre-paid card, the market monitors can also enter data directly into the internet through Postasurf, a facility provided by the Postal Corporation of Kenya and which is now available at all district headquarters (Jama, et al., 2004). The LINKS office checks on data accuracy and timeliness and provides training and technical back up to the network of supervisors and monitors. There are also a number of Non-Governmental Organizations (NGOs) that provide complementary support to improve data collection and information dissemination. The information is available to a wide range of users including policy makers, NGOs, community-based livestock traders and producer associations and individuals, middlemen and the private sector. The information is downloaded and could be saved into a computer so that national institutions can in turn print it and share it with other users and communities of livestock producers. The information is also available if requested through SMS and is also shared by e-mail and posted on billboards at the market places where both producers and traders can access the same (Kaitho et al., 2004).

With support from the Kenya Livestock Marketing Council (KLMC) and the Netherlands Development Organization (SNV-Kenya), the system has expanded to cover fifteen major markets. The approach to implementation involves intensifying awareness on the utility of the system among potential users and adopting dissemination and training approaches that reach a wide clientele while keeping the costs of achieving this to a minimum. Involving collaborators in this process ensures a larger multiplier effect and helps to build confidence in the use and adoption of the technology. The system has incorporated a number of attributes to ensure the effectiveness of livestock market in terms of its usefulness for producers and traders and also consumers to make timely informed decisions. These include regular and consistent reporting on a weekly basis, development of a grading system based on defined animal characteristics, a system that transfers data to a central processing unit and accessing the information through different media. The system also has the potential to provide information on lag time involved in transporting animals from one market to another, the estimated cost involved and ability to forecast how the markets are likely to perform in the future. LINKS has made significant contributions in developing a livestock marketing information system that is acceptable to a wide array of partners in Kenya. This has been through training of monitors and end-users of the information, participating in livestock stakeholders meetings, presenting LINKS protocols at different fora, developing training and dissemination materials, and organizing demonstrations on the use of the short message service to send and query data. Over 61 representatives from government, NGOs, private consultants, and traders have participated in these trainings. Three presentations have been made at local meetings of livestock stakeholders and collaborators involving over 70 participants representing 20 different institutions. A field day demonstrating the use of the system to traders, government, county council and NGOs staff was held at Garissa market where over 500 posters and information flyers were distributed. This was complemented with a training session of 14 users with access to the internet. The institutions involved in implementing the NLMIS now include Ministry of Livestock and Fisheries Development, Kenya Livestock Marketing Council, FARM-Africa, Food and Agriculture Organization Veterinaires Sans Frontiers (VSF-Suisse), Food for the Hungry International (FHI), and Terra Nuova Kenya.

Through the Nairobi Support to Emergency Preparedness and Response office, FAO has made a major contribution to the NLMIS by supporting workshops to sensitize a wide array of stakeholders at the district level. The workshops were conducted in 14 districts of Isiolo, Marsabit, Moyale, Mandera, Wajir, Garissa, Samburu, Baringo, Wets Pokot, Turkana, Kilifi, Kajiado, Narok, and Laikipia, involving a total of 308 participants representing different organizations. The major objective of these workshops was to mobilize stakeholders in the different markets and districts to expand the NLMIS and solicit further support for this expansion and sustainability of the system. During the workshops, a total of 31 other markets were identified for inclusion in to the monitoring network. Following the successful district workshops, the stakeholders identified and nominated persons to be trained as monitors to facilitate inclusion of the additional markets into the NLMIS. A total of 20 supervisors based at the Provincial or District headquarters and 52 other staff drawn from 35 markets in 19 districts within four provinces were trained in two consecutive workshops held in Nairobi. The coordinating committee of the NLMIS has also developed a proposal for implementation and expansion of the system.

Conclusion

Basic information communication technology can play a major role in improving connectivity among markets and this can help communities of livestock producers identify markets for their livestock and have improved knowledge

on prices in those markets. Developing the technical and human capacity to meet market information needs and decision support for livestock producers helps to bridge the gap between markets on the one hand and producers on the other. This means that producers can make better choices on where to sell their animals and creates leeway to have better bargaining power with traders. To make this a reality requires support by government in terms of development and adoption of a policy that guarantees access to information communication technology to a wide clientele especially in the more remote areas where marketing of livestock is a major activity.

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Design by Susan L. Johnson

GLOBAL LIVESTOCK CRSP

Analysis of the November 2005- April 2006 Drought in Kenya

Robert Kaitho, Joseph Ndungu, Jerry Stuth, Gatarwa Kariuki and Abdi Jama
Livestock Information Network and Knowledge System (LINKS) Project

Research Brief 06-02-LINKS August 2006

Increasing frequency of drought occurrences and a decline in the capacity of traditional mechanisms to deal with this situation is increasingly becoming a serious threat to the livelihoods of a majority of people who depend on livestock. Over three million people are currently faced with starvation due to the prevailing drought in Kenya. The challenges posed by this emerging scenario demand that decision makers devise and adopt new ways of dealing with the situation. The collection, analysis, dissemination and use of early warning information are necessary for equipping agencies and communities of livestock producers with the tools to aid in timely decision-making. This brief demonstrates how the technologies developed by the Global Livestock Collaborative Research Support Program were able to effectively track the conditions that resulted to the current drought in Kenya. The analysis is based on information derived from forage conditions and also shows how this affected livestock condition and prices. It is suggested that equipping decision makers and livestock producers with early warning tools will help them make informed choices for moving and marketing livestock and identifying appropriate options to reduce the risk of asset loss when droughts occur.

Background

Drought constitutes one of the greatest threats to people's livelihoods in agricultural and grazing lands throughout the world. Many areas in the world are experiencing changing drought frequencies and temporal shifts in precipitation and temperatures. Chances of drought occurring in parts of the Greater Horn of Africa have increased from a probability of one in six years to one in three years. Repeated occurrences of drought and high variability in precipitation have reduced the ability of pastoral communities in the region to maintain their assets while lack of timely early warning information has reduced their capacity to respond when conditions are still good. Decision makers in these areas are finding that traditional coping strategies of farmers, ranchers and pastoralists are not appropriate for the changing conditions, thus requiring new innovations in characterizing, monitoring, analyzing and communicating the emergence of drought conditions in good time.

In recent years, great strides have been made in satellite–based weather monitoring systems, information and communication and modeling technologies to allow integration of spatially explicit, near real-time weather data acquisition with sophisticated automated modeling tools to predict the amounts of forage available within given locations at given times. The Livestock Early Warning System (LEWS) project of the Global Livestock Collaborative Research Support Program led by Texas A&M University developed a spatial forage-based early warning system since 1997. This is an automated modeling, Geographic Information System and communications technology package where real-time, satellite weather data is used to drive a biophysical model known as PHYGROW (Phytomass Growth Simulator) to produce daily estimates of forage conditions every 10 days with up to 90-day forecasts since 1999. The model is the foundation of the LEWS toolkit designed to monitor the impact of emerging weather events on forage supply for livestock in the pastoral regions of eastern Africa. The model uses soil parameters, plant community characteristics, livestock traditional management decision rules and weather data for a particular location to simulate daily forage available for livestock and other major herbivores. Various geo-statistical methods and GIS techniques are employed to produce surface maps of available forage using the point data generated through the automation process. Using the Auto Regressive Moving Average (ARIMA) forage forecasting technology developed by LEWS (Kaitho et al., 2003), a comprehensive view of emerging forage conditions of up to 90 days is updated every 30 days.

Emergence of the Current Drought in Kenya

Available forage and weather data shows that the LEWS model tracked the forage situation on the ground very well. The forecasts issued in September 2005 and updated

monthly had warned of emerging forage scarcity and subsequently deteriorating animal condition. This forecast was made before the expected November-December rains and the forecast tracked very well with the realized rainfall and forage condition. The areas forecasted to have severe forage deviations (drought) were in Northeastern (Mandera, Wajir, Garissa) Southeastern (Machakos, Kitui, Makueni, Kajiado) and parts of the Coast province (Kwale, Kilifi). Most of these areas had experienced consecutive seasonal rainfall deficits culminating in the drought and lack of pasture for livestock and therefore the deficient rainfall experienced during the November-December season aggravated the drought situation. The monthly forecasts updates provided in October and December covering January and February 2006 indicated a rapid decline in forage conditions as these areas were expected to have mainly sunny and dry conditions. The Climate Outlook Forum and FEWS-NET have confirmed that the LEWS forecast was on target because it clearly indicated the forage scenario observed. The field data collected in the project monitoring sites since 2001 was highly correlated with the PHYGROW available forage simulated model outputs (R2=0.96 and SEP=161 kg/ha) (Jama et al., 2003).

Using the data from January 2001 to December 2005 on the 60-day forecasts and available forage matching the forecasts indicated that the ARIMA time series forecasting methodology provided suitable projections well within normal sampling errors. The observed R2 and SEP (kg/ha) values for the 30, 60 and 90-day forecast of grazeable standing crop were 0.97/83, 0.92/139, and 0.87/185 respectively (Figure 1). The forecasting power decreases as the time horizon is increased but still remains good even after 90 days.

Historical Forage and Drought Trends

Many parts of Kenya have been experiencing severe drought conditions for many months with likely devastating impacts to many livelihood systems including loss of large numbers of livestock and lack of food. LEWS forage and deviation maps indicate that:

- Many areas in Turkana district have been under drought conditions since August 2005.
- In Garissa district, some of the sites have consistently been under drought since June 2004.
- Areas in Wajir have experienced extensive drought since February 2005.
- In Mandera, emergence of drought started from November 2005 with the hot spot spreading from across the border with Somalia.
- In Makindu, emergence of drought started earlier than August 2004.

Graphical tracking of forage condition and 60-day forecasts is available at http://glews.tamu.edu/africa. Continued drought in these areas would have far reaching impacts if no proper intervention strategies are put in place.

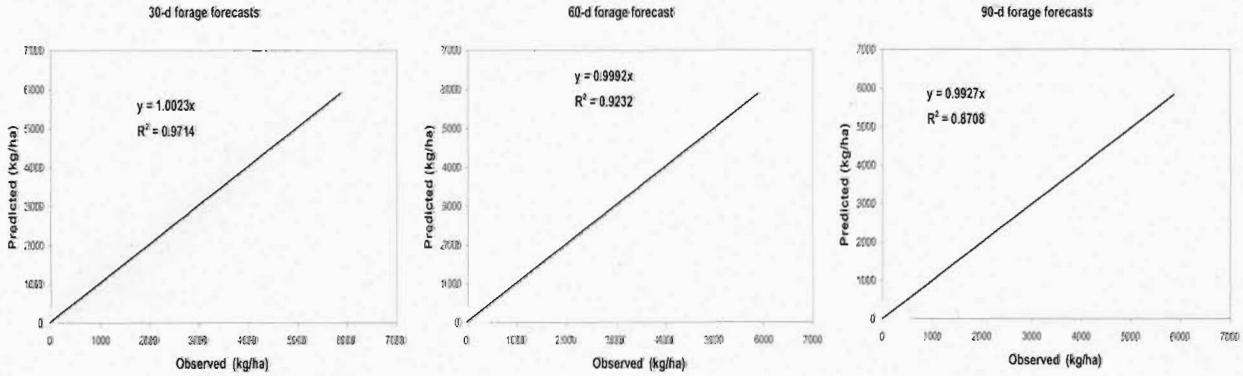
Forage Outlook

The forage outlook for the period March to May 2006 produced by GL-CRSP/ LINKS and available at the 17th Climate Outlook Forum for the GHA bulletin (http://www.icpac.net/Forecasts/GHACOF17/GHACOF17_statement.html) shows that the forage situation will remain poor and continue to decline in many parts of pastoral areas. The specific areas that will deteriorate further include southern lowlands, North Eastern and Turkana in Kenya. Forage conditions are expected to improve in South Rift Valley in Kenya. The 60-day forecasts by the LEWS team indicate no relief from these conditions for the next 2 months.

Livestock Marketing Information

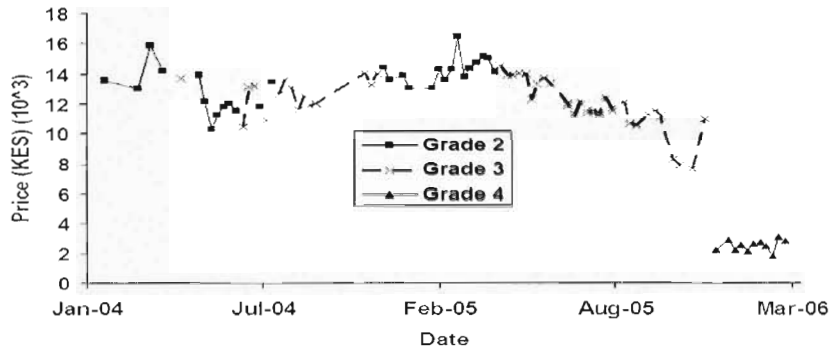
Since September 2005, cattle prices in all the primary markets have decreased significantly (LINKS, 2006). The market trend analysis by GL-CRSP/ LINKS shows a price drop in December. This could be associated with a large number of animals taken to the market on the same week after the drought signal was raised leading to a drop in price due to high supply as compared to demand. Livestock prices reflect animal grade and condition. For instance in Wajir,

Figure 1. Relationship between observed and predicted 30, 60 and 90-day forage forecasts from Jan 2001 to Dec 2005.



animal condition started deteriorating to a point where the market was dominated by grade 3 rather than grade 2 animals and prices were declining. Furthermore, there was emergence of poor grade 4 animals in the secondary markets towards the end of December (Figure 2). The analysis indicates that livestock prices are associated with animal condition which is affected by, among others, forage availability. Declining livestock prices in the markets therefore reflect deteriorating animal body condition and as the situation worsens animals start dying. Very high livestock mortalities due to shortage of forage and water have been reported in many areas while the prices of cereals particularly maize have been rising (KFSMG, 2006). Due to the weakening pastoralists' terms of trade for cereals therefore, malnutrition rates are expected to rise among the chronically food insecure populations in the pastoral areas. This scenario strengthens the case for providing timely flow of early warning information to livestock producers to equip them with choices for making better decisions to move and market livestock during both normal and distress periods so as to minimize the risk of having their livelihood assets decimated.

Figure 2. Livestock prices in Wajir market, Kenya.



Dissemination Channels for the Early Warning Information

The forage early warning information is distributed through various channels such as WorldSpace radio (via ALIN and RANET containers), internet and email and monthly situation reports. In addition, LEWS contributes to the FEWS-NET GHA Food Security Bulletin and the Climate Outlook Forum for the GHA Bulletin. With partners, efforts are under way to identify ways of improving the packaging and dissemination of the information to insure it reaches a wide range of users in easily understandable forms at the appropriate place and time. The aim is to integrate the forage-based spatial livestock early warning system into the food security analysis and early warning system throughout the pastoral and mixed farming regions of Kenya.

Conclusion

The GL-CRSP has now infused two valuable tools into the eastern Africa region which if used in a timely way by decision makers should offer substantial lead time to make rational decisions on how to respond to threats of drought. When coupled with market indicators from the newly established livestock marketing information system that spans several countries, decision makers are not only getting a local but also a regional picture of the plight of pastoral people. The challenge is to strengthen the use of the livestock early warning and marketing information systems in key organizations and broaden the coverage and dissemination among pastoral communities. Equipping agencies and communities with appropriate tools and information will help them plan for and respond to emerging drought situations. This is based on the firm belief that if the right institutions and mechanisms are put in place, most drought-associated disasters that are currently facing many communities could be mitigated, providing communities with sustainable means of meeting the demands for food and other basic necessities of life so that they can be part of the global vision of achieving the Millennium Development Goals.

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Design by Susan L. Johnson

GLOBAL LIVESTOCK CRSP

Kenya Adopts LINKS Technologies to Provide Information for the National Livestock Marketing Information System

Gatarwa Kariuki and Robert Kaitho
Livestock Information Network and Knowledge System (LINKS) Project

Research Brief 06-03-LINKS August 2006

The lack of and need for price information in many of the pastoral areas of Kenya remains a critical concern by producers, traders and policy makers. This in spite of the emergence of organized market intelligence particularly in relation to prices at terminal markets. In the past a number of livestock marketing information systems initiatives have been implemented in Kenya but with limited coverage, accessibility and use. LINKS has developed a livestock marketing information system based on information communication technologies that has now been adopted as the basis for developing a national livestock marketing information system for Kenya, implemented in collaboration with the Ministry of Livestock and Fisheries Development and a number of development partners. From an initial three markets it now covers 15 main markets and is still expanding.

Introduction

There is renewed institutional focus on improving livestock market information, infrastructure and efficiency to address the needs of livestock keeping communities to improve cash income from the sale of livestock and livestock products. Due to insufficient information, pastoralists or traders cannot plan or justify incurring certain marketing costs in the face of uncertain receipts. If information is limiting, providing information through regular and timely price broadcasts may have significant, positive effects. From both a research and development perspective, there is general consensus that livestock marketing information plays a role in influencing decisions to dispose of livestock not only for local consumption, but also through the market chain. The latter avails opportunities for livestock keepers to generate income to meet the exigencies of pastoral livestock households and in the process contribute to poverty reduction and improved livelihoods (Mbogoh et al. 2005). The effectiveness of livestock market information is measured primarily in terms of its usefulness to producers and traders and also consumers in helping them make timely informed decisions (Aklilu, 2002). Evidence-based analysis also shows that market information reduces risks in marketing (Bailey et al. 1999). A number of factors influence access to information: these include distance to markets; cost of collecting and analyzing the data and disseminating the information; availability, access, and cost of information and communication infrastructure; and the utility of that information in aiding decision making. The advantage that traders may have over producers can best be eliminated through enhancing competition and maintaining marketing infrastructure and information systems. If producers have access to improved information systems, they can bypass a number of middlemen for price mediation, and link more directly to consumers and hence increase their share of the final product value. Colby (1990) supports the argument that if livestock producers have to strengthen their position against buyers, they have to check on prices and general market conditions before selling.

Past and Current MIS Initiatives

In the past, a number of Market Information Systems (MIS) schemes aimed at smallholder farmers and pastoralists have been attempted throughout Kenya. The United Nations Development Program (UNDP) started a MIS in 1978 dealing with the main markets in Kenya until 1991 when United States Agency for International Development (USAID) funded the Kenya Marketing Development Project, including the MIS system, until 2000. These MIS systems contained little or no information on livestock. Beginning 2000, the Inter-Governmental Authority on Development (IGAD) supplied information on a range of commodities but no data on livestock or their products other than egg prices were reported. With support from the German bilateral agency Gesellschaft für Technische Zusammenarbeit (GTZ), the Marsabit Development Project funded the collection, processing, and dissemination of livestock market information in the then Marsabit district for several years. The dissemination process was not extremely intensive, but traders appeared to have used it extensively (Bailey et al, 1999). The information was broadcast by radio in two local languages but because

of the limited number of radios among the pastoral communities, these radio broadcasts had limited impact (Bailey et al, 1999). Efforts to have the local county council and traders support the dissemination of the information by charging five (5) Kenya shillings (approximately 7 US cents) for each head of cattle sold did not bear fruit either; the MIS became unsustainable and was abandoned.

Within the then Ministry of Livestock Development, livestock marketing officers collected data and sent a report at the end of each month. This data would then be synthesized to a monthly report which also allowed animal owners to advertise if they had animals to sell. This reporting system however collapsed in early 1990s. A study by Colby (1990) indicated that although the division had then been in existence for more than 15 years and livestock marketing information was one of its core businesses, there were no reports or studies showing if and how this information had been used in decision making and if so what the impact had been on the livestock sector and pastoral livelihoods. Between 1990 and 1996 the Ministry, with support from the Overseas Development Administration (now the Department for International Development) of the United Kingdom, implemented the Rural Services Design Project in the districts of Kajiado and Narok in southern Kenya. Within the marketing component, monitors collected data on all the days when the markets were active. Each market monitor then relayed the data through VHF radios to Nairobi, where all the data was compiled to a single unit and relayed back to all the reporting sites. The service was discontinued after some eight months on the basis that information was limited in coverage and was not adequate to have a significant impact in the national livestock marketing sphere. In addition, the initiative was dogged by challenges including lack of transport for monitors some of whom had to travel more than 50 km to reach the markets.

The NGO Swiss Vétérinaires Sans Frontiers (VSF-Suisse) initiated a project for gathering and disseminating livestock market price information in Somalia and districts in northeastern Kenya. Mostly, transmission of information was done via telephone, fax, internet or spot delivery (mainly in Nairobi). Data was supposed to be processed daily in the VSF-Suisse regional office in Nairobi and sent back to the different markets the same day by use of SMS and posted on bill boards that are placed at the market centers, a claim that was never fulfilled. With support from the World Bank, the Arid Lands Resource Management Project (ALRMP) also initiated a project that included gathering information from markets daily for onward transmission to ALRMP headquarters in Nairobi, where it was to be analyzed and transmitted to the districts at a cost, in local languages, by Kenya Broadcasting Corporation, leading to delays of reporting this information. Apart from insufficient funding, it was argued that the MIS was not sustainable because accurate information was not forthcoming and secondly the information was already available to the traders who were able to transmit it to their counterparts at the district level. To serve the needs of producers it was proposed that users associations be strengthened and empowered to collect and disseminate livestock marketing information. The Kenya Livestock Marketing Council (KLMC) was formed for this purpose. Recently the African Development Bank released funding for a livestock and rural livelihoods support project to be implemented in 22 districts in the arid and semi arid lands of Kenya through the Ministry of Livestock and Fisheries Development (MoLFD). A marketing information network is one of the program's key interventions to address the need for timely and quality information decision making.

Coordinating efforts to develop National Livestock Marketing Information System (NLMIS)

LINKS has responded to the livestock marketing information needs by designing an information communication technology infrastructure for reporting and requesting information on livestock prices and sales volumes from a network of different markets in Kenya. In partnership with other collaborators, LINKS has been integrated into a livestock marketing information system that facilitates dissemination of information so as to reach end users in the remote livestock producing areas. To avoid duplication in data collection, stakeholders agreed to establish a coordinated effort with the aim of minimizing cost and necessity of having more than one system of collecting the same data. The objectives of the NLMIS are to avail information through various media to all players in livestock marketing, establish a livestock marketing database for reference in planning, research and monitoring of marketing trends. The information is available to a wide range of users including policy makers, NGOs, community-based livestock traders and producer associations and individuals, middlemen and the private sector. The information is available on request fusing cellphone SMS and email. It is also available on the web at http://www.lmiske.net. The information is downloadable and could be saved into a computer so that national institutions can in turn print it and share it with other users and communities of livestock producers. Building a strong foundation in reliable technology and fundamental institutional buy-in has positioned the LINKS project to enter the next phase of challenges and issues that need to be addressed to ensure stability of the system.

As part of its contribution, FARM-Africa supported a workshop that was held in Nairobi bringing together participants from the private sector, development agencies, non-governmental organizations, community-based

organizations and the public sector. The specific objectives of the workshop were to: i) create awareness about the existence of a national livestock marketing information system and its functioning, ii) give an opportunity to suggest ways to improve the system and, iii) chart the way forward in the area of long-term financing of the system for sustainability. In the opening speech read on his behalf by the Permanent Secretary, the Minister for Livestock and Fisheries Development noted that technology had changed tremendously ushering in the age of the internet and mobile telephony, and that the future of market information is certainly brightened by this development in the information communication infrastructure. He called upon the stakeholders at the forefront of implementing and expanding the NLMIS to explore ways and means of sustaining the system through self-financing. He singled out the Ministry of Local Government that is in-charge of local authorities in the country as one of the institutions that are well equipped in the area of revenue collection in livestock trade and part of that revenue could assist in financing the system.

Accomplishments

The approach to implementation and expansion of the NLMIS involves intensifying awareness on the utility of the system among potential users and adopting dissemination and training approaches that reach a wide clientele while keeping the costs of achieving this to a minimum. Involving collaborators in this process ensures a larger multiplier effect and helps to build confidence in the use and adoption of the technologies. The system has incorporated a number of attributes to ensure the effectiveness of livestock markets in terms of its usefulness for producers and traders and also consumers to make timely informed decisions. These include regular and consistent reporting on a weekly basis, development of a grading system based on defined animal characteristics, a system that transfers data to a central processing unit and accessing the information through different media. The system also has the potential to provide information on lag time involved in transporting animals from one market to another, the estimated associated transfer costs, and ability to forecast how the markets are likely to perform in the future. LINKS has made significant contributions in developing a livestock marketing information system that is acceptable to a wide array of partners in Kenya. A special training program will also be developed for livestock traders via their trade associations throughout the country to assist in effective use of the information for their decision making processes. A follow up survey will be conducted to determine how the NLMIS is impacting on decision making processes for the different groups of users.

Conclusion and Policy Implications

The world is fast accelerating along the information superhighways. Access to mobile telephony and internet helps to alleviate rural isolation and this contributes to development. Delivery, consumption and use of reliable, accurate and timely information at the producer level, coupled with knowledge about market prices in other markets, is expected to enhance the capacity of livestock producers to negotiate for better prices for their livestock. To make this a reality however requires support by stakeholders in terms of development and adoption of policies that guarantee access to information communication technologies and infrastructure to a wide clientele especially in the more remote areas where marketing of livestock is a major activity contributing to the social, cultural and economic needs of their inhabitants. This should be complemented with policies that facilitate the production and supply of animals that satisfy sanitary and phytosanitary standards for export markets to meet the increasing demand for livestock-based products being fuelled by population growth, urbanization, and income growth in developing countries.

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Design by Susan L. Johnson

GLOBAL LIVESTOCK CRSP

Assessing Market Integration in the Presence of Transaction Costs: The Case of Pastoral Livestock Markets

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Livestock Information Network and Knowledge System (LINKS) Project

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Market integration occurs when product flows between markets are on the same terms and conditions as within markets. A highly integrated commodity market is likely to increase market efficiency through efficient resource allocation and price transmission, which is likely to lower transaction costs and increase incomes to actors. Price data collected by the Livestock Information Network and Knowledge System (LINKS) project of the Global Livestock Collaborative Research Support Program led by Texas A & M University were used to assess the degree of livestock market integration by testing whether livestock prices in Nairobi and pastoral areas of Garissa and Isiolo are cointegrated or move together. Data from livestock traders' survey done in Nairobi and Garissa were also used to examine market characteristics. Key findings indicate that all the three livestock markets exhibit non-stationarity (statistical parameters are dependent on time) and integration of order one and that, whenever there is shock to the price in one market it will be manifested in the other market as well.

Background

Pastoral communities are dependent upon and bound to livestock. Livestock provides pastoral communities with food (meat, milk and blood), income (sale of livestock and livestock products), self-employment opportunities and in addition serves as an important store of wealth, insurance and prestige. The pastoral system is primarily geared towards meeting the subsistence needs of the pastoralists by providing the major ingredients of their diets and for enhancing social relationships. However livestock has acquired a niche in the national, regional and global livestock trading chains and livestock producers are part of the commercial webs of trade relationships with livestock providing the means for financing their basic needs expenditures (Barret and Luseno, 2001; Kariuki, 2001). Understanding the pastoral livestock markets is key to development of arid and semi-arid areas of Kenya which account for about 8% of the country's population and occupy roughly 63% of the total land area (Narman, 1990; Republic of Kenya, 1994) and developing the pastoral livestock markets is key to poverty alleviation.

Market integration occurs when product flows between markets are on the same terms and conditions as within markets. A highly integrated commodity market is likely to increase market efficiency through efficient resource allocation and price transmission, which is likely to lower transaction costs and increase incomes to actors. Moving towards market integration is done by removing barriers towards commercial exchange. The three kinds of barriers are natural, cultural (language, information, preference) and political. Barriers create a wedge between prices, tariffs are added to prices, quotas create shortages that drive price up and transportation costs raise prices. Price convergence is one of the four measures of integration, the other measures are factor markets, trade volumes and product availability.

This study was set to find out if the pastoral livestock markets are cointegrated (move together and have a long run relationship). The markets under study were Nairobi, Isiolo and Garissa livestock markets. The study hypothesised that Isiolo, Garissa and Nairobi goat price series are non-stationary (the statistical parameters are dependent on time) and that pairs of categorised livestock markets (Isiolo and Garissa, Garissa and Nairobi, and Isiolo and Garissa) are not cointegrated.

Methodology

Primary data was collected through a livestock traders' survey by use of a structured questionnaire in Garissa and Nairobi markets. A purposive random sampling procedure was used to come up with the desired livestock traders to be interviewed. Secondary data used was time series price data collected by the Livestock Information Network and Knowledge System (LINKS) project of the Global Livestock Collaborative Research Support Program led by Texas A & M University. The traders' survey data was entered and analysed using the statistical package for social scientists (SPSS) software, while the time series livestock price data was entered in Ms-Excel and analysed in Econometric Views (EViews) software. The following steps were followed during analysis; the livestock price series for Nairobi, Garissa and Isiolo

were tested for stationarity using the Augmented Dickey-Fuller (ADF) unit root test. After confirmation of non-stationarity the price series were tested for cointegration using the Johansen method (1988).

Results

Descriptive analyses done on the traders survey data provide information on the market characteristics indicated that most pastoral livestock markets were under the control of local authorities in terms of the general management. Traders pay market cess to the local authority for maintenance of various facilities. Livestock trade is done by men in the most productive age bracket of 15 to 49 years old. The mean age of the livestock traders interviewed was 40 years. Maasai and Somali are the predominant tribes supplying livestock to Nairobi and Garissa markets respectively. All of the goats and sheep traders interviewed operating in Nairobi market also operate in other markets as well.

Cattle brought to Garissa market are sourced from Wajir district and a few from within Garissa while the small stock like sheep and goats are from within Garissa district, areas of Dadaab, Modogashe and Shantaabak. Trekking is the most preferred mode of transporting animals to the market. At Dagorreti market in Nairobi, most stocks are from Narok, while another smaller percentage come from Ewaso Nyiro and Kajiado. However, the small stock (goats and sheep) are sourced from Wajir, Marsabit, Garissa, Somali and Samburu. In the Nairobi market, most goats and sheep are brought by trucks.

Most of the traders interviewed preferred to use information from people known to them at a personal level in the business, 60% in Garissa and 80% in Nairobi. However, in the marketing chain, brokers are also used in selling and sourcing animals at an agreed fee. The brokers reduce the search and negotiation times in buying and selling of animals. The brokerage fees for selling a goat or sheep is Ksh 20 while that for cattle is Ksh 100. In general, a livestock trader incurs the costs in the course of livestock trading: storage, transport costs for trekking and trucking animals, market cess, loading and offloading costs. Since most of the animals go straight to the next market after sourcing, only 25% of the traders spent money on storage which was on average between Ksh 250 and 750. Transportation to the terminal market was cited as a major cost to the trade. It costs from between Ksh 18,000 to Ksh 25,000 to hire a ten ton lorry load of cattle or sheep from Garissa or Isiolo to Nairobi irrespective of the number of animals on the truck.

The livestock price trend analysis showed that Nairobi cattle and goat prices were higher than Garissa and Isiolo prices during the period under study (February 2003 to December 2004). Nairobi cattle and goat prices were even higher during the months when Garissa and Isiolo markets were under quarantine. Econonometric analysis (Eviews) shows that Nairobi, Garissa and Isiolo time series price data are non-stationary and are integrated of order one. The cointegration tests using Johansen procedure (Table 1) show that there is cointegration between Isiolo and Nairobi goat markets as well as Garissa and Nairobi goat markets and no cointegration between Isiolo and Garissa markets. The presence of cointegration indicates a long run price relationship in the markets, revealing that the prices will move together overtime and converge towards equilibrium in the long run. The results also show that a shock to the price in one market will manifest in the other market as well. The absence of cointegration between Isiolo and Garissa goat markets which are both source markets feeding Nairobi indicate that the two markets are independent of each other and have no long run price relationship. Consequently, a price shock in Isiolo does not mean a corresponding reaction in Garissa market.

Table 1. Johansen cointegration procedure of Nairobi, Garissa and Isiolo goat markets.

Goat market	Category	Eigenvalue	Likelihood Ratio (LR)	Hypothesized No. of Cointegrating Equations	Reject or Accept the Null Hypothesis
Nairobi and Isiolo	One	0.25	23.02	None	Reject
Nairobi and Isiolo	One	0.06	4.23	At most one	Accept
Garissa and Nairobi	Two	0.23	23.90	None	Reject
Garissa and Nairobi	Two	0.09	6.83	At most one	Accept
Isiolo and Garissa	Three	0.12	13.03	None	Accept
Isiolo and Garissa	Three	0.06	4.60	At most one	Reject
5% critical values			19.96		
5% critical values			9.24		

Source: Authors calculation 2004

The cointegration relationship and vector error correction model showed that Isiolo and Garissa market prices have a positive long run relationship with Nairobi goat market prices.

Granger Causality tests were done on the market prices. The test for Granger Causality involves examining whether lagged values of one series have significant in-sample explanatory power for another variable. Granger Causality showed that Isiolo goat prices granger cause Nairobi prices but not vice versa and that Garissa does not granger cause Nairobi prices. This provides a proof of the direction of price flow from the source market to the terminal market as it implies that whenever there is a positive change in Isiolo goat market, the Nairobi goat market reacts to that change positively. The goat volumes from Garissa market is not large enough to affect the Nairobi market prices.

Conclusions

The main conclusions from the study are that Isiolo and Nairobi, and Garissa and Nairobi goat markets are cointegrated and have a long run price relationship. However, the direction of the relation differs. Isiolo and Nairobi have a positive long run relationship while Garissa and Nairobi have a negative long run relationship. Consequently, whenever there is shock to the price in one market it will be manifested in the other market as well.

Practical Recommendations

- The goat and cattle price trend shows that whenever the government imposes quarantine in the source markets, then the terminal market prices go up. For example, Nairobi prices rose up when Isiolo and Garissa markets were on quarantine.

- Since the source markets (Garissa and Isiolo) have a long run relationship with the terminal markets (Nairobi), it is important for the government to focus on development of these source markets especially for supply to Nairobi.

- Results showed that there is positive cointegration between Isiolo and Nairobi goat market. This means that if Isiolo goat prices go up, then Nairobi goat prices will also increase.

- Survey results indicate that trekking is the most preferred mode of transport for cattle to the primary markets in Isiolo and Garissa markets hence the government and other development agencies should focus on developing the stock trekking routes to include watering points.

- Reducing lorry transport costs means increased incomes for the pastoral communities. The government should look into ways of reducing the cost of diesel as well as investing on having better road networks.

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The GL-CRSP Livestock Information Network and Knowledge System (LINKS) project developed from the GL-CRSP Livestock Early Warning System (LEWS) project which was established in 1997. The LEWS project developed and applied a suite of information communication technology to provide a regional decision-support framework for livestock early warning. The LINKS project is placing LEWS technology inside a broader livestock information and analysis system that is designed to improve livestock markets and trade, thereby enhancing the well-being of pastoralists in eastern Africa. The project was led by Dr. Jerry W. Stuth, Texas A&M University until his death in April 2006. The project is now led by Dr. Paul Dyke, Texas A&M University. Email contact: dyke@brc.tamus.edu.

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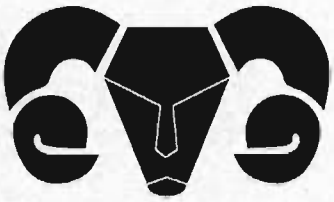

Expansion of LEWS Activities in Ethiopia Under the Pastoralist Livelihoods Initiative (PLI)

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In the recent past, pastoralists of Ethiopia have become increasingly food insecure and vulnerable to drought and other shocks. This trend is corroborated by high levels of food aid and evidence that coping mechanisms are weakening. Through a Pastoralist Livelihoods Initiative (PLI) that began in October 2005, the USAID-Ethiopia Mission supported Ethiopia in undertaking urgent and timely interventions to respond immediately to emergencies and to improve livestock production and early warning systems targeted at reducing the prospect of disasters due to recurrent droughts (USAID, 2005). The Livestock Information Network and Knowledge System (LINKS) project is one of the multiple partners that contributed significantly to the implementation of the PLI. This brief describes the contribution of the LINKS project towards the establishment and strengthening of the capacity of the Somali and Afar regional states of Ethiopia to institute and manage region-wide district-based pastoral livestock Early Warning Systems (EWS).

Background

The Pastoralist Livelihoods Initiative (PLI), implemented through a collaboration of the Government of Ethiopia, private sector, non-govermental organizations (NGOs), and universities was a project focused on strengthening livestock-based livelihoods through a variety of proven interventions including: early market purchase of stock before severe drought; restocking with improved breeds of small ruminants (sheep and goats), while improving productivity of existing breeding stock; and by exploiting immediate opportunities for long term livestock market development (including policy reform and public/private partnerships for systems improvement).

The PLI sought to urgently address the needs of an increasingly vulnerable population made so by climatic conditions (i.e. drought and lack of access to markets). The overall objectives of the PLI is to mitigate the impact of drought and other shocks by sustainably improving the preparedness, livelihoods and incomes of pastoralists.

The Pastoralist Livelihoods Initiative has four intermediate result-oriented objectives:

1. Optimization of stocking rates and production of livestock in the extensive grazing areas of the regional states of Somali and Afar and the pastoral lowlands of the regional state of Oromia;

2. Preparation of pastoralists for droughts and other shocks through the establishment of livestock specific early warning and response mechanisms in Somali and Afar;

3. Increase of income for pastoralist through efficient off-take of livestock and animal products from the pastoral areas of Somali and Afar and the pastoral lowlands of Oromia due to improved access to well-organized livestock markets; and

4. Harmonization of technical and policy processes to support the strengthening of pastoralist preparedness, livelihoods, and incomes.

Under objective two above, the GL-CRSP Livestock Information Network and Knowledge System (LINKS) project was awarded funding from the United States Agency for International Development (USAID) to undertake technology transfer in order to implement the Livestock Early Warning System (LEWS) technology suite, developed by the LINKS team of Texas A&M University, in the Afar and Somali regions of Ethiopia. The overall goal of this objective was to reduce the vulnerability of the populations of Somali and Afar to food insecurity and related hardships by improving the regional capacities to monitor and analyze food and livelihood security information and to advocate for timely and appropriate responses.

The LINKS project has developed a suite of tools for monitoring the impact of emerging weather events on livestock forage supply in the pastoral regions of eastern Africa. Of particular note is the Livestock Early Warning System (LEWS) technology. LEWS is a robust suite of automated technologies that utilize satellite based weather data, Normalized Difference Vegetation Index (NDVI) data, and geo-referenced measured vegetation

sites scattered across East Africa to monitor deviation in forage production for livestock compared to long-term data with projected 90 day forecasts provided every 10 days to an array of collaborating institutions. LEWS utilizes the Phytomass Growth Model (PHYGROW- Rowen, 1995) as the foundation, whose primary inputs include soil parameters, plant community characteristics, and livestock management decision rules, which are driven by gridded weather data for a particular location to simulate daily forage available for livestock and wildlife (Stuth et al., 2003 and 2005).

The LINKS project worked in partnership with Save the Children-UK (SC-UK) to establish an effective and sustainable district-level food and livelihood security monitoring and early warning system (EWS) within Somali and Afar, focused on triggering timely and appropriate responses. The objective of the proposed EWS was to strengthen the capacity of the Somali and Afar Regional Disaster Prevention and Preparedness Food Security Bureaus (DPPFSBs) to establish and manage region-wide district-based pastoral EWSs that are linked to appropriate and early responses through a food and livelihood security monitoring, reporting, analysis, and dissemination system. Such a system was proposed to complement the Ethiopian government's Federal Disaster Prevention and Preparedness Commission's efforts to establish a livelihood-based EWS in the country. The role of LINKS in the consortium was to augment and bolster the content of early warning information and products produced for and by the PLI by offering a robust suite of livestock early warning and livestock market information products and technologies, and complement partner activities from SC-UK. The products that LINKS continues to provide include: current and forecasted forage production for livestock, generated automatically from satellite based weather data; NDVI data; and geo-referenced measured vegetation. This forage production information is delivered every 10 days via the Internet, along with monthly reports of 30, 60, and 90 day forecasts for forage production. The livestock market information avails near-real time weekly market prices and supply transaction information for key markets, as well as an updated analysis and synthesis of market trends as they relate to the food security situation of pastoral areas.

Justification. Presently, SC-UK utilizes the Household Economy approach (the sum of household income and the exchange value of its labour and other assets) to estimate the impact of a 'shock' on the ability of a household to acquire food and non-food goods. This information is used to manage threats to food security through provision of timely and analytical early warning and vulnerability information. The process involves the monitoring of key indicators and response triggers that are physically observed in the field on a regular basis and tied to a "warning stages" categorization. These indicators include forage standing crops that must be physically observed on a regular basis. The livelihoods assessment requires actual regular physical visits to the field by monitoring experts. In order to undertake assessments and determine standing forage conditions in comparison to the norm, eye-ball estimations of deviation from a single reference "normal" year over the last ten-year period are carried out by the monitors. This methodology poses some practical and methodological challenges towards monitoring forage conditions. Insecurity and denial of access due to the insecure nature of the pastoral environments makes regular visits difficult. Sampling may also be difficult and compromised due to poor accessibility rendering regular return assessments impractical. Physical monitoring by individual monitors in different locations introduces individual biases leading to lack of standardization of the survey outputs for comparison among and across multiple locations or areas. Furthermore, a lack of long-term institutional memory (both due to regular staff transfers and human cognitive remembrance abilities) makes the process of objective determination of deviations of current forage situations in comparison to long-term normals near impossible.

The LEWS technology suite addresses these issues by providing a scientifically grounded empirical basis for determining forage standing crop conditions. Furthermore, given the fact the monitoring is an automated process, the information and data about forage conditions have been stored in a database since 1961, meaning determination of deviation of current forage situations can be calculated on the fly. Once the forage model has been set-up, no further regular visits are required as the model automatically generates new forage information based on changing climatic variables that are automatically captured from satellite weather information of various web-repositories. The information is generated in near real-time, providing statistical predictions and an insight into future forage conditions.

Methodology

The expansion of forage monitoring locations arose from the need to fill critical gaps in the LEWS monitoring system in Ethiopia. After careful analysis, it was determined that at least 50 monitoring points were required in the Somali region, with 25 more in the Afar region in order to create a well balanced distribution of monitoring locations that will provide a much more objective and robust representation of vegetation/land use classifications, and thereby forage production units. The expansion of monitoring locations enhances the accuracy of the LEWS forage monitoring and early warning products by increasing the sampling frame and therefore the representation of the heterogeneity of landscapes of interest. The bulk of the activity was undertaken between October 2005 and September 2007. The field activities involved field characterization of

dominant plant species, characterization of the dominant soil series, gathering information on plant preferences by animal types, stocking rates, and traditional grazing decision rules. Each monitoring site was geo-referenced and linked with both rainfall data and Normalized Difference Vegetation Index greenness data for the region. Once the vegetation information was entered and stabilized into the PHYGROW model, weather data information and NDVI coordinates were set up and associated with each monitoring site to produce forage standing conditions for analysis and forecasting.

Significant Outputs

Like crop production, forage production is a supply indicator. The livelihood security of pastoralists relies not only on forage production, but on access to that forage. Sufficient forage production does not guarantee that all pastoralists have forage entitlements. Pastoralists' forage entitlements are determined by other factors, such as land tenure, infrastructure, borders, and conflict. Nevertheless, if forage production is poor, the impact on pastoral livelihoods can be substantial.

The project saw the completion of the expansion of vegetation monitoring locations in Somali and Afar. Over eighty new sampling sites have now been established to complement previous existing monitoring locations. The forage production information being generated at these new locations has been integrated into the forage early warning/ forage monitoring system and has tremendously improved the accuracy of the forage production information being generated for Ethiopia.

The information collected has formed a solid foundation for the development and targeting of suitable early warning interventions in the pastoral areas of Ethiopia. Accurate targeting of emergency interventions to monitor and protect pastoral livelihoods and reduce the requirements for emergency assistance is currently being achieved by use of the forage monitoring/early warning information generated by a number of emergency intervention institutions working in Ethiopia including: DPPFSBs, USAID, SC-UK, Famine Early Warning Systems Network (FEWSNET), and the World Food Programme (WFP), among others. Detailed region-specific maps of forage conditions are now being produced for both Somali and Afar every ten days, information that is currently being integrated in routine food security monitoring activities and the reporting of the respective regions' food security agencies. With the increase in monitoring locations, many users and stakeholders have developed confidence in the new set of products, including maps of forage production, proving that the information is both scientifically and practically sound, capable, and accurate enough to be used for both early warning and planning purposes.

Practical Implications

Livestock entitlements are the most important assets for pastoralists, while livelihood strategies such as herd management, employment and migration patterns, marketing patterns and income generating activities determine how pastoralists cope with advancing drought. A forward-looking social protection system needs to intervene early, ideally right after a weather shock, which in the case of Ethiopia tends to be lack of rain during critical months. Rainfall and forage monitoring are very useful in the early detection of emerging problems for pastoralists. Employing techniques such as LEWS, monitoring can be carried out cheaply and cost effectively for large areas, through remote sensing and biophysical modeling techniques.

The LEWS forage monitoring products supply a comprehensive set of early warning indicators that provide accurate information to trigger responses to drought conditions and acute food insecurity, as well as useful input for post-emergency interventions and development planning.

With the improvement in confidence gained from the expansion of monitoring locations, the LEWS products have been targeted as the technology of choice for use in an early livelihood protection index being developed in the pastoral areas of Ethiopia (Hess et al., 2006), and LEWS technologies are also being integrated into a risk financing strategy established by WFP, DFID (UK Department for International Development), and the World Bank.

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GLOBAL LIVESTOCK CRSP

Assessment of Livestock Market Information Systems in the Highland Regions of Ethiopia

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The lack of properly functioning markets has been pointed out as one of the key issues underlying the recurrent food crisis in Ethiopia and in other countries in the eastern Africa region. Many issues and constraints need to be tackled to create an efficient livestock marketing system. The absence of livestock market information is one such constraint facing livestock producers in Ethiopia in their efforts to earn a fair return from the sale of their livestock. Access to market information enables these producers to seek out and compare the information available for different market outlets and to realize the full potential profit by getting the best prices. The Sanitary and Phyto-sanitary Standards and Livestock and Meat Marketing (SPS-LMM) program of the Texas Agricultural Experiment Station commissioned an assessment of the livestock market information systems in the highland regions of Ethiopia. The main objective of the assessment was to determine the prevailing status of Livestock Market Information Systems in these areas and subsequently help identify opportunities and constraints towards the development of a unified national livestock market information system in Ethiopia. This brief describes the findings of this assessment study carried out by the Livestock Information Network and Knowledge System (LINKS) project of the Global Livestock Collaborative Research Support Program (GL-CRSP), in collaboration with the SPS-LMM project.

Background

Livestock marketing information is needed to improve decision making at all levels in the livestock industry and to enhance the competitive position of the Ethiopian livestock industry in international markets. The skewed access to livestock market information towards traders means that rural livestock producers have little or no knowledge of prevailing prices in different regions, and as such, they are unable to fetch the best possible prices for their livestock (Mukhebi, 1999).

Irregular and sporadic livestock market data collections have been going on in many of the eastern African countries for a long time, primarily as components of development projects such as the Arid Land Resource Management Project (ALRMP) in Kenya, the Tanzania Livestock Marketing Project (TLMP) in Tanzania, and in government ministries and by NGOs (CARE-Ethiopia) in Ethiopia. The Livestock Information Network and Knowledge System (LINKS) project, implemented by the Texas Agricultural Experiment Station (TAES) at Texas A&M University (TAMU), and the Livestock Market Information System project of the USAID-funded Southern Tier program of the Department of Livestock and Fish Marketing of Ethiopia's Ministry of Agriculture and Rural Development (MoARD) initiated one of the first attempts at establishing a National Livestock Market Information System in Ethiopia.

In recognition of the successful attempts by the LINKS project to implement a Livestock Market Information System in the pastoral areas of Ethiopia, the SPS-LMM project of TAES- TAMU commissioned a study to assess livestock market information systems in the highland regions of Ethiopia with the objective of gaining an insight into the existing livestock market information systems there, and informing next steps for the creation of a unified national market information system that covers both pastoral and highland regions of Ethiopia.

The goal of the assessment was to gather information about any existing livestock market information systems and services at the various levels of the government in the highland regions of Ethiopia and help identify constraints and opportunities that would contribute towards the development of a successful unified National Livestock Market Information System along the lines of what has already been achieved in the pastoral regions (Jama et al., 2006).

The LINKS team conducted a fieldwork assessment in Southern Nations, Nationalities, and People's Region (SNNPR), Amhara, Tigray and Oromiya Regions in the period between May 24-June 15, 2006 using structured interviews with key informants, including informants at the key government offices, traders, and grassroots level livestock keepers. The findings of the study are expected to aid the MoARD in fine-tuning and improving ongoing efforts in the implementation of a standard Livestock Marketing Information System (LMIS) in the country.

Major Findings

Significant overlaps and duplication of activities exist among the services that collect livestock market information at every level of the government (districts, zones, regions and the federal level). Moreover, there are weak institutional linkages, lack of effective collaborations and coordination, and poor working relationship among stakeholders and institutions involved in LMIS.

- Key organizations currently involved in livestock market information in the highland regions include: Bureau of Agriculture and Rural Development (Livestock Department), Disaster Prevention and Preparedness Bureau, Agricultural Marketing Agencies (new development), Bureau of Trade and Industry, and to a lesser extent, the Central Statistical Authority.

- Most of the organizations are collecting not only livestock market information but also information on other agricultural products such as cereals and crops, the latter of which is the primary information collected in most cases.

- Too much information is collected and stored in raw format at government offices in hard copies, and it is not clear to most government officers why they are collecting this information. The information is not analyzed and packaged for dissemination to the desired beneficiaries.

- Long delays exists in data transmission from the markets to the government offices.

- Frequent government bureau restructuring has caused losses in institutional memory as personnel are reallocated from one unit to another, and there exists a significantly high turnover rate of market monitors and experts.

- Lack of standards for data collection, even within the same bureaus, appears to be a significant challenge for the data collection processes.

- Most of the traders interviewed were in favor of the idea of creating a uniform, reliable livestock market information system, and they have indicated a willingness to pay minimal fees for the service provided, as long as it is regular and on a near real-time basis.

- In most of the highland market transactions, buyers and sellers deal directly with each other without the involvement of brokers. This makes the provision of market information to the producers particularly beneficial in order to level the playing field.

- Most of the traders and producers interviewed indicated that they would like to receive market information not only about the local markets, but also about distant central and terminal markets in the country.

Practical Implications

Despite all the problems mentioned above, it was apparent from the rapid assessment conducted in the highland regions that a Livestock Marketing Information System should be a feasible and a worthwhile investment given the increasing demand to provide near-real time market information to end users. This is due to the fact that the producers in the highlands deal directly with the traders without the involvement of brokers or middlemen, as is the case in the pastoral regions, where informed brokers bargain on behalf of producers to get a fair price for their livestock.

Long-term. Market information will remain a public asset in Ethiopia for quite some time. Federal and regional governments must make efforts to make information accessible to all stakeholders. This information is an important element for the country, becoming a basis for stimulating trade and economic growth, encouraging public and private investment, and consequently generating economic and social development. In the long term, subsequent off-shoots in the private sector will occur when specific niche market needs have to be met, and entrepreneurial individuals may follow the models applied in the developed countries by taking this free public information, adding value to it, and selling it to serve the specific niche demand.

Short-term. Goodwill, appreciation and capacity-building seem to be the some of the most required investments in the short-term, in order to promote the capacities of market technicians and professionals. The survey carried out pointed to the fact that most of the monitors simply require appreciation of their efforts to get their job done. It is vital that the country works on the creation of a legal framework that supports the work on LMIS development within government departments (both at regional and federal level), in order for them to obtain the institutional backing that brings federal and/or regional budgetary commitment.

Sustainability of LMIS. All local key institutions at the various levels of the government must be involved in the planning, development and deployment phases of the LMIS program to ensure their ownership of the service, to be able to perhaps provide the necessary resources to increase the efficiency of the system, and to insure the sustainability and viability of a Livestock Market Information System. Some limited donor support and technical assistance might

be needed in the initial phases of the program. Willingness on the part of the government to support LMIS at the policy level is crucial to the success and sustainability of a National LMIS. Concerted efforts should be made to design a simple but useful system that could be managed within the regular budget allocations of the government agencies that have the mandate for operating the system.

Implementation of a policy framework. It is apparent from the assessment that issues of livestock market information cut across many programs and institutions. As such, it is evident that no single institution can be self-sufficient in handling the whole system by itself. However, a single institution needs to be identified as the lead organization for the overall coordination of the LMIS program at all levels. A clear national policy framework is a prerequisite to facilitate harmonization, cooperation and coordination among the various organizations. The policy framework is necessary to maximize mutual benefits and reduce unnecessary duplication of efforts for the implementation of a holistic and coherent program.

Institutional framework for the implementation of national livestock market information. New regional agricultural marketing agencies are emerging in most of the highland regions and seem to offer the potential to be the regional homes for the livestock information system. The Agricultural Input and Marketing agency promises to be the ideal coordinator at the federal level. They need to set up steering and technical committees composed of the major actors (agricultural and rural development, trade and industry bureaus, radio networks, etc.) to coordinate and to avoid duplication of efforts and resources.

Capacity building. Significant efforts should be made to enhance the institutional capacity of the "woredas," both in terms of human development and equipment, and to ensure collection and delivery of information on a timely basis to all market participants. Careful recruitment and appropriate training will be needed to build a strong technical team. These staff should be given the task of market monitoring as their priority. The promotion of training and capacity building for local stakeholders, particularly major managers and practitioners of LMIS is crucial. Management and technical committees representing these stakeholders with expertise and perspectives from both the public and private sectors will need to be set up to promote a transparent image and instill team commitment.

Standardization of LMIS. A National LMIS requires standardization of, at the very least, data-formats to allow easy comparison of prices. There is a real and expressed need to standardize the livestock market data collection in the country to allow for comparability among various regions. It would be prudent to build on the experience and the integrated format and design that came out of USAID Southern Tier Initiative of Ministry of Agriculture and Rural Development (MoARD) and LINKS projects.

Scope of coverage. The scope of the data collection activities in the highlands needs to be limited at the beginning to a small number of vital markets in each of the regions and expanded to other markets once a reliable system has been stabilized and as resources allow.

Improving distribution and dissemination of livestock market information. The impact of the Livestock Market Information System will ultimately be determined by the extent to which producers, livestock traders and policy makers utilize the information generated to aid their decision processes. Currently, dissemination appears to be the weakest link in the whole process of livestock market information. A proactive approach will be needed to improve targeted channeling of the LMIS. The challenge will be in finding ways to improve access of the market information by rural communities. The increasing coverage of the mobile-phone network, regional FM radio stations and the GovNet (formerly Woredanet) seem to hold promise to improve this situation. Traders are already ahead of the game in exploiting mobile telephone technology to keep them updated on both local and terminal markets.

Enhanced use of Information Communication Technologies (ICTs). The use of modern ICTs in LMIS is quicker and most cost effective in transferring information on a near real-time (i.e. Fax, Email, Internet and phone) basis. Using modern ICTs eliminates the chances of loosing information, as it goes straight to the rightful inbox, web portal, fax machine or telephone as required, unlike the ordinary postal communication delivery system, which can easily result in information losses or misdirection and distortion. The amount of field and desk work required to produce livestock market information could be reduced through automation of data collection and processing and dissemination using a software/hardware architecture that makes use of the state-of-the-art telecommunication technologies.

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GLOBAL LIVESTOCK CRSP

The National Livestock Marketing Information System Comes of Age in Kenya

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LINKS Project

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Following consultations and demonstration of the functioning of the Livestock Information Network and Knowledge System (LINKS) project ICT (information and communication technology) in reporting and disseminating livestock prices, stakeholders in livestock marketing adopted the LINKS protocol to develop a national livestock marketing information system (NLMIS) for Kenya. The result is a culmination of efforts of different stakeholders to give the country a unified system that provides information on prices of different livestock species that are traded in the key livestock markets. The overall objective of the NLMIS is to increase market access for livestock producers and traders. The NLMIS allows users to bring down the costs of doing business by reducing reliance on brokers for information and to conduct market transactions on their behalf, as illustrated by the case of one Peneti Ole Parmuat, a Maasai herder and trader from Kajiado district of southern Kenya.

Background

Beginning 2003, the Livestock Information Network and Knowledge System (LINKS), in collaboration with the Ministry of Livestock and Fisheries Development, designed and piloted an information communication technology module for reporting livestock prices, mainly focusing on markets in the pastoral areas. The initial pilot markets were Garissa and Isiolo as secondary markets and Nairobi as the major destination market for the live animals. The ministry nominated members of their staff that were trained on how to sample animals and interview and record data from respondents at the market level. These trained staff were also provided with cell phones for use in reporting the data collected. The monitors would record the data on paper, after which they were taken through the process of coding the data to fit the Short Message Service (SMS) reporting protocol. They would then convert the data to coded alphanumeric messages that are fed into the cellphone and sent to a number that communicates with and delivers the messages to the server.

Livestock market monitors, their supervisors and representatives of relevant non-government and community based organizations are trained on how to download, analyze and summarize the information for transmission to end users in a form that fits their requirements and are called upon to help download and disseminate the information using appropriate media. Information is shared using a combination of channels, which include radio, print media, SMS, Email, Worldspace and Internet. For local users, information is printed and posted at strategic offices and on billboards that are erected in the markets and updated regularly so that the larger public can have access as well. The LINKS office, in collaboration with field supervisors, ensures that monitors report data of reliable quality consistently and on time, as provided in the reporting protocol. The field supervisors also maintain custody of the original hard copy data sheets.

Major Findings

After stabilizing and testing the reporting system, another three markets were added into the network – Moyale, Wajir, and Marsabit. In January 2005, at a workshop in Nairobi, the livestock information system was demonstrated to other stakeholders who had expressed interest in developing livestock marketing information systems for the communities of livestock producers which whom they were working. After consultations and collective evaluation of the system, it was unanimously agreed that the underlying technology be adopted to develop a national livestock marketing information system for Kenya. Leading the pack of stakeholders were organizations such as the Kenya Livestock Marketing Council (KLMC), FARM-Africa and Vetèrinairès Sans Frontiers (VSF) Suisse, who were already running some versions of marketing information systems in their areas of mandate. A committee of representatives from these organizations was then formed to coordinate the implementation and expansion of the NLMIS.

The first task that the coordinating committee undertook was to develop a road map for the future of NLMIS. The team felt that it was necessary to sensitize other stakeholders representing government,

LINKS training session at Maralal Town Market.

The Ministry, through the Livestock and Livelihoods Project (ALLPRO) funded by African Development Bank, has extended to one other market.

The markets that are actively reporting include: Nairobi, Garissa, Wajir, Moyale, Marsabit, Isiolo, Mandera, Mombasa, Chepareria in West Pokot, Emali in Kajiado, Marigat in Baringo, Garsen in Tana River, Suguta in Samburu, and Rumuruti in Laikipia West districts. Training sessions have been conducted for four groups of monitors, while 33 market level trainings targeting producers and traders have been conducted in 15 districts.

non-governmental organizations, community-based organizations, local authorities, and the private sector at the district level, to their support for the system and also to their advice on which markets they considered to be key, and which could then be connected to the reporting network.

The stakeholder sessions were held towards the end of 2005 and covered fourteen districts of Isiolo, Marsabit, Moyale, Mandera, Wajir, Garissa, Samburu, Baringo, West Pokot, Turkana, Kilifi, Kajiado, Narok, and Laikipia. Using outputs from the workshops, the coordinating committee developed a proposal for financing the NLMIS beginning in 2006. In its response, FARM-Africa, through the Community Animal Health Network, funded a workshop in May 2006 for policy makers representing over 30 organizations.

The objectives of the workshop were to give policy makers an opportunity to suggest ways to improve the system and chart the way forward in the area of long-term financing, taking into account issues of sustainability. As an outcome from the workshop, KLMC committed to supporting an additional four markets. The system has since expanded from six to 14 markets, with the Kenya Livestock Marketing Council supporting seven additional markets.

Case Study: Peneti Ole Parmut and the NLMIS

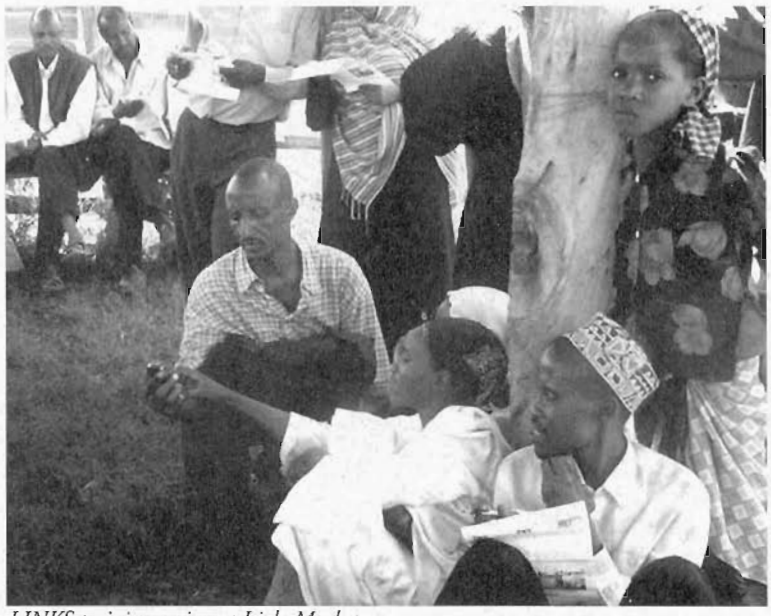
Peneti Ole Parmuat is a Maasai herder from Kajiado district of southern Kenya and makes his living selling livestock, mainly cattle. With improvements in communication infrastructure, Ole Peneti no longer relies on local friends and middlemen. He uses his cellphone to make voice calls or sends text messages through SMS to the NLMIS server to get information on prices of cattle in the markets. The server generates an automated response and provides information on prices in the market requested. Based on the cost of transporting the animals by truck and the time it takes to get his cattle to the market, he is able to make a decision on which market to deliver his animals. According to Ole Peneti, prior knowledge of the expected average prices in different markets has improved his bargaining power to negotiate for better prices, and he has gradually become independent of middlemen in the livestock marketing chain. This has helped Ole Peneti to improve his income, which enables him to better meet the household demands and needs of his family.

The crowning moment came on July 31, 2007, when Kenya's Minister of Livestock and Fisheries Development, the Honorable Joseph Munyao, formally launched the National Livestock Marketing Information System. The minister emphasized that the greatest component that needed to be addressed was ensuring that livestock producers and the primary market traders have access to the information and that dissemination of the information generated should be high on the priority list.

Munyao called upon and encouraged any organizations that were running, or had plans to develop marketing information systems, to join hands and implement a single rich national livestock marketing information system. This would provide the opportunity to get more value for the resources each organization planned to spend by getting encompassing national information and reaching a wider clientele through joint collective dissemination efforts. He also appealed to media houses to dedicate space and airtime to disseminate the information generated by the livestock marketing information system and mobile telephone operators to explore ways of contributing to the system through support to data gathering.

Practical Implications

The public-private partnership interaction in developing the national system is very useful in unlocking information flows on livestock marketing. Improved access to spatial information on livestock marketing is yet another milestone in the livestock sub-sector in Kenya and is set to revolutionize the way business in this sector is conducted in future.



LINKS training session at Isiolo Market.

The livestock marketing information system provides timely information to enhance transparency and efficiency in livestock marketing, support decision making that provides source alternatives, and sell livestock through markets offering better returns for producers and traders. Given the cross-border nature of livestock trade, the system offers a regional framework where markets can collaborate, network and share information. The system is expected to enhance decision-making in livestock trade and improve the bargaining position of sellers to negotiate for better prices. Equipping market agencies and communities of livestock keepers with appropriate tools and information will help them plan for and respond to changing market conditions, including better opportunities to sell their livestock. This will lead to increased incomes and consequently improved livelihoods, particularly for livestock keepers in the more disadvantaged arid and semi-arid pastoral areas of eastern Africa.

How does the system impact communities of livestock producers? Developing the technical and human capacity to meet market information needs and decision support for livestock producers helps to bridge the gap between markets on the one hand, and producers on the other. This means that producers can make better choices on where to sell their animals and have more leverage to bargain with traders. This in turn translates to improved returns to their marketing transactions, and therefore an enhancement of their economic status. The cash generated meets expenditures for goods and services that they cannot produce at home. This not only helps them to improve the livelihoods of their households, but also creates demand for goods and services in the local and national market arenas. Socially, it means that information can be targeted to reach specific gender, age, and wealth categories to reach a wider range of clientele, which helps producers to form and strengthen marketing associations and pool resources to invest in marketing that enables them to reduce per capita transaction costs.

LINKS training session at Maralal Livestock Market.

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GLOBAL LIVESTOCK CRSP

The Influence of Water Stability on Livestock Migration in Northern Kenya

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The Livestock Information Network and Knowledge System (LINKS) and the Livestock Early Warning System (LEWS) projects have determined that water availability and stability are major factors in pastoralists' decision making about livestock movement. To obtain information on the water situation in the LEWS (Livestock Early Warning System) monitoring sites in northern Kenya, LINKS launched the study described in this brief. The location of the water sources used by LEWS communities, particularly those that dry up and are abandoned during prolonged dry season or drought periods, were mapped to enable assessment and monitoring of water availability using forage deviation data. The information gathered will be used alongside the forage advisories as a basis for decision making and intervention by pastoral communities, development/relief agencies, and other stakeholders.

Background

The LEWS/LINKS projects have determined that water stability influences livestock migration in northern Kenya. Monitoring and characterizing water availability (particularly in areas of unpredictable drought) is an important component of a livestock early warning system. The purpose of the study described in this brief was thus to obtain information on the water situation in the LEWS (Livestock Early Warning System) monitoring sites in northern Kenya. Team members mapped the location of the water sources used by LEWS communities to relate the time (month and dekad) when water sources dried up with the corresponding forage deviation in order to enable assessment and monitoring of water availability using forage deviation data.

In the LEWS monitoring zones, the districts that had been affected by drought over the previous two years were identified. Within these districts, specific areas (sites where people and their livestock actually moved or migrated for various reasons) were selected; these were areas where it was likely that some or all the water sources either dried up or were abandoned. Pastoral communities and other key informants in the selected monitoring sites were interviewed by administering a single questionnaire in a focus group discussion. Single subject interviews were conducted to verify some of the responses with key informants.

The specific objectives of the survey included: 1) to identify and characterize the water sources available to pastoral and agro-pastoral communities in the LEWS monitoring sites, and 2) to establish the role of water stability in influencing decisions on livestock movement.

Preliminary Findings

The respondent communities were able to articulate the issues of forage, water and livestock movement very well in all sites for the period in question (January 2004 – May 2006). In all sites, the meetings were facilitated by Ministry of Livestock and Forestry Department (MoLFD) staff, the area Chief or community monitor.

Livestock Movement

Forage situation and livestock movement. The forage situations in the northern Kenya districts of Isiolo, Samburu, Marsabit and Laikipia were generally below normal over the survey period. At the time of the survey during the long rainy season in May 2006, only a few areas had adequate forage. Most areas had not recovered from drought, and conditions were deteriorating fast, as was the case in Tiemamut in Laikipia, where livestock were being moved out due to scarcity of forage. In northern Kenya, almost all the grazing resources are communally owned.

In all sites, the pastoralist communities moved their livestock from normal grazing areas in search of water and pasture during times of stress such as dry season and drought periods. In one site (Baragoi) out of seven (14.3%) only cattle were moved to satellite herding camps locally known as 'fora,' while camels, sheep and goats grazed within the home area. In Sibiloi-Gas, camels were moved separately while cattle and small stock were moved together. The movement patterns and grazing areas were different. Cattle were also moved quite early because, as grazers, they are usually the first to be affected by shortage of forage and water. A few lactating animals (camels and goats) are usually left behind during

migration to provide milk for household consumption. In all sites, the homesteads ('manyatta') are sedentary, while only the livestock migrate along with the herders.

Reasons for movement. In five sites (71.4%), shortage of forage was a primary consideration and inadequate water for livestock a major factor in the decision to move to other grazing areas. Only in one out of 40 total movements (2.5%) was water cited as the primary reason for movement whereby forage was a lesser factor. Insecurity/conflict was cited in three (42.9%) of the sites (Sibiloi-Gas, Baragoi and Serolevi) as a reason why people moved. Pastoralists in Sibiloi-Gas recounted how 341 camels were stolen in a village called Moite near Lake Turkana in January 2006, forcing them to vacate the area. In all sites, livestock returned home as soon as forage conditions improved with the onset of the rainy season. If the rains are scanty, however, some (especially cattle) might not return for prolonged periods.

Migration distances and duration away from homestead. Mobility is the single most important tool used by pastoralists to manage and utilise rangelands. A total of 40 movements away from respective home grazing ranges were made in the seven sites over the 28-month survey period (January 2004 to April 2006). Of these, 11 involved all livestock species, 12 for cattle and small stock, 10 for cattle and seven for camels only. The average duration away from home was 4.7 months with a range of two to 28 months across livestock species. The period covered by the survey was generally unfavorable in terms of forage, culminating in severe drought from November 2005 to April 2006. In normal years, only cattle are moved during the dry season, but camels and small stock utilize nearby grazing areas.

Distances covered per migration movement varied widely between sites and livestock species. The overall range was seven to 110 kilometers (km) with an average of 56 km. The shortest distances of 10 km were in Baragoi, Kiwanja and Serolipi, and the longest of 120 km in Tiemamut, Wamba and Maikona. Distances increased as the adverse period of forage scarcity advanced. Cases of insecurity were reported as the livestock moved outside their traditional grazing areas leading to conflicts with neighboring communities.

Livestock mortalities during the November 2005 to April 2006 drought were high in some parts of Isiolo and Marsabit, but not so much in Samburu and Laikipia districts. Most affected were Sericho and Merti divisions, while the least affected was Kinna division. Isiolo district is a net migration area for livestock from North Eastern province. In 2005, there was also a huge influx of livestock from other areas into Baragoi division due to the poor rains received that year in the rest of Samburu (Waso, Maralal) and Marsabit districts.

Migration routes: description, determinants and problems. In 42.9% of the sites, all livestock were moved together along the same route when migrating. Different species, however, move at different speeds and have various requirements of feed and water. The major determining factor of the chosen route is availability of water and pasture en route and at destination (71.4%) because of long distances and slow pace of movement. In Laikipia, the migrating herds have to follow established roads to avoid trespassing into the many private ranches.

Wildlife menace, insecurity, shortage of water, and pasture along the trek route were each cited in 42.9% of the sites as the main problems encountered en route. Other obstacles included disease and rough terrain in 28.6% of the sites. Although most pastoralists are used to frequent migration, those left behind may have limited or no access to milk and other food items. Food scarcity and risk of starvation are thus a possibility; and the household might have to rely on food relief to survive the prolonged periods when livestock are away.

*Table 1. Water constraints in the key survey sites. *(K=Kiwanja, SE=Serolevi, M=Maikona, SB=Sibiloi-Gas, B=Baragoi, W=Wamba, T=Tiemamut Group Ranch).*

No.	Constraint	K*	SE	M	SG	B	W	T	Frequency (%)
1	Long distance to water	x	x	x	x	x			71.4
2	Inadequate/ seasonal water	x	x	x	x	x	x		85.7
3	Parasites (liver flukes) in water	x							14.3
4	Grazing areas have no water			x					14.3
5	Contamination/ poor sanitation	x	x						28.6
6	Competition from wildlife		x				x	x	42.9
7	Disease transmission		x						14.3
8	High labour needs in dry season							x	14.3
9	High watering charges					x			14.3
10	Lack of water along trek routes							x	14.3
11	Water for human use far away			x					14.3

Water Sources

Characteristics of available water sources. The type, number and characteristics of water sources vary from site to site. Wells, the most common type, comprised 37.5% of the water sources in northern Kenya followed by dams (18.8%), rivers (14.6%), boreholes (12.5%)

*Table 2. Interventions to improve access to water for livestock. *(K=Kiwanja, SE=Serolevi, M=Maikona, SB=Sibiloi-Gas, B=Baragoi, W=Wamba, T=Tiemamut Group Ranch).*

No.	Intervention	K*	SE	M	SG	B	W	T	Frequency (%)
1	Develop new water sources in grazing areas without water	x	x	x		x		x	71.4
2	Develop sand dams along laggas		x	x			x	x	57.1
3	Improve forage availability in areas with sufficient water			x	x	x			42.9
4	Rain water harvesting at strategic points and storage tanks						x	x	28.6
5	Regulate use of river water upstream	x							14.3
6	Improve town sewage disposal and treatment	x							14.3
7	Deepen wells that produce little water				x				14.3
8	Create awareness on best use, treatment and conservation of water						x		14.3
9	Protection of water sources e.g. fencing dams						x		14.3
10	Develop rock catchment dams to collect mountain water						x		14.3

and springs (6.3%). Others were Lake Turkana, seasonal rivers ('lagga'), surface ponds and rock catchments. Unlike the other water sources, wells are found in most grazing areas because they are easy to develop and can be deepened as the need arises.

Different water sources are important at different times of the year; however, the order of use is site specific and depends on availability of other water sources in the grazing area. The seasonal rivers are usually used first because they have water only when it is raining. They are followed by dams/pans, wells and finally the permanent sources. Wells are mostly used during the dry season after the other sources are exhausted because they are labour intensive.

The duration of water at a source varies widely. The lake, all springs and boreholes, five of the seven rivers, and 72.2% of the wells have water rated to be sufficient for livestock throughout the year. Only two-thirds of the dams hold water for more than three months in a year, and only one-third of them produced adequate water. Most water sources are communally owned, except some boreholes managed by water user associations on behalf of the pastoralists that may require some maintenance charges to water livestock.

Although not the primary consideration in decisions to move livestock, water availability was still an important determining factor. In most cases, livestock were grazed in the proximity of water sources within a radius of up to ten km. With implementation of grazing management plans, areas without reliable water such as Segel, Hurri hills and Dida Galgallu in Marsabit district were utilized during the wet season when livestock requirements for water were low and surface rain water was accessible. Such areas were also utilized during extreme dry season and drought periods when there is no grass elsewhere, forcing livestock to trek for 30 to 50 km to and from grazing and water sources.

Constraints and coping strategies in providing water to livestock. The major constraints in provision of water to livestock and humans in pastoral areas of northern Kenya were inadequacy and long distances to the watering points (Table 1). Due to low and erratic rainfall and lack of permanent sources, water availability in most areas is seasonal and dries up after a few months. Livestock then must be moved to other areas or trek long distances between watering points and grazing sites, as most trek routes do not have water en route.

Other coping strategies include digging and deepening wells along dry river beds. Competition and interference from wildlife, especially elephants, and contamination of water sources by parasites and sewage effluent were other noted constraints. Animals can contract diseases at common watering points when infected herds mix with others, affecting both livestock and human health status. Raising awareness on proper sanitation and parasite control, however, may reduce the impact of these problems.

Interventions to improve access to water for livestock. Most communities interviewed felt that water supply for livestock use could be improved by developing more water sources, e.g. developing sand dams, regulation or deepening wells (Table 2). Improving pasture availability in areas with adequate water but little or no pasture was also cited as a viable intervention, e.g. in Hurri hills and Segel areas in Marsabit district. This could be done through implementation of grazing management plans by the respective environmental management committees, range rehabilitation, and the timely delivery of early warning information to pastoral communities. Rain water harvesting is a feasible option particularly for domestic water. Above all, however, the communities acknowledged that water development is costly and should be done strategically to prevent range degradation.

Practical Implications

Forage and water availability and disease are currently the most important limiting factors for livestock production in ASAL. They are made worse by the insecurity arising from resource-based conflicts, political strife, livestock rustling and banditry. When drought sets in, water sources dry up, forage dwindles, and animal health deteriorates very fast.

Migration is the most important strategy for pure pastoralist communities but is not always invoked in time or in patterns optimal for resource productivity. Pure pastoralists, in general, have set migration routes and only diverge from existing patterns in the face of severe drought or outbreak of disease epidemics. Water management, especially the use of alternative water sources and change of watering frequency, is another coping strategy. But, how viable, timely, efficient, adequate or sustainable these strategies are today given the increasing frequency of drought episodes remains questionable. Reliable information for early warning on the status of forage and water availability, coupled with planned migration patterns have a very important role to play in sustainable development of rangelands.

Availability of reliable sources of water is still a major constraint to livestock productivity in the rangelands of northern Kenya. There may be room for development of more water sources in some areas, but the distance between them should be large enough to discourage concentration of large numbers of livestock on inadequate land area, thereby causing rangeland degradation and reducing the carrying capacity. Thus, permanent water sources should be widely spaced (no closer than 20 km apart), while temporary sources could be interspersed to allow effective dispersal of herds to control overgrazing and degradation. Water sources, where possible, should be integrated into community-based resource management systems, and close-by human settlement should be discouraged through community regulatory systems.

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GLOBAL LIVESTOCK CRSP

From LINKS to NLMIS: Issues, Challenges and Lessons Learned

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LINKS Project

Research Brief 09-01-LINKS April 2009

Information communication technology, specifically the mobile phone, is becoming an integral tool for development, as there is increasing recognition that information is an important tool in empowering people to make progress both economically and socially. The suite of technologies developed by the Livestock Information Network and Knowledge System (LINKS) project was adopted to develop and implement a national livestock marketing information system (NLMIS) for Kenya. The system was formally launched on July 31, 2007 as a single rich system that provides opportunities to add value by gathering national information and reaching a wide clientele through collective dissemination efforts. The system, the first in Kenya, provides the country with a unified system of information on prices of different livestock species traded in key livestock markets. This brief provides an overview of the market-based training programs conducted to launch the NLMIS, along with the challenges and lessons learned in its implementation. The authors find that following introduction of the NLMIS, data collection and uploading were proceeding smoothly in the markets networked, and that a large number of people, both at the offices and in the markets, were able to access the information. The NLMIS is part of the vision for the development of pastoral areas; through improving information flow to livestock producers and traders, they become equipped with the knowledge to make better choices on livestock marketing, thereby enhancing income and livelihoods.

Background

Following a successful stakeholder collective approach in investing resources and adopting Livestock Information Network and Knowledge System (LINKS) technology towards developing a national livestock marketing information system (NLMIS) for Kenya (Kariuki and Kaitho, 2006), the system was formally launched on July 31, 2007 by Kenya's Minister for Livestock and Fisheries Development. The NLMIS, an integrated suite of technologies based on GL-CRSP LINKS project research, is designed to capture market price and trade information as well as characteristics critical to the supply side of livestock marketing throughout Kenya. The system, which links cell phones operated by producers and traders with a centralized livestock market information database, has proven useful in unlocking information flow, allowing improved access to spatial information on livestock marketing for even those in Kenya's remote pastoral areas. The NLMIS is considered to be yet another milestone in livestock development in Kenya, and is set to revolutionize the way business in this sub-sector is conducted in future. This Research Brief investigates the progress of the NLMIS in Kenya (for a detailed account of NLMIS development, see Kariuki and Kaitho, 2006), specifically the efficiency and outreach capacity of the system.

Reaching out to users. In late 2007, the NLMIS coordinating team organized a number of market and producer level training workshops in several districts and markets to publicize the system (Mwangi et al. 2007). To support these workshops, the Kenya Livestock Marketing Council applied for funding from the Food and Agriculture Organization (FAO). The funding enabled a team of four collaborators to visit 31 markets spread over 13 districts in four provinces of Kenya. The Ministry of Livestock and Fisheries Development and LINKS project provided logistical support in the form of vehicles. Table 1 (next page) shows the distribution of markets, by province and district, where the trainings were conducted. In addition the team also visited and trained the management of the Kenya Meat Commission based at Athi River. In total, NLMIS training in Kiswahili (the national language of Kenya) directly reached over 5,000 people in 2007.

The workshops. During the visits, workshops were held to create awareness about the system. Participants were informed about reporting markets, the NLMIS database, and uploading and retrieval methods. One of the methods, for example, employs downloading information from the Internet, which includes information for all major livestock. Another method utilizes mobile phone short message service (SMS) technology, which has been expanded to include the prices of all livestock species from earlier models that provided price information on only an index cattle breed (the Boran mature male). Other practical demonstrations of the SMS information retrieval method followed, and participants were trained on the querying of prices from various markets, receiving all results in real time.

Table 1. Distribution of markets by District and Province where LINKS NLMIS training workshops were conducted in 2007.

Province	Districts	Markets
Eastern	Isiolo Marsabit Moyale	Kinna, Oldonyiro Marsabit town, Merille Moyale town, Odda
Northeastern	Garissa Wajir Mandera Ijara	Garissa town, Dadaab Wajir town, Habaswein Mandera town, Rhamu, Takaba Kotile
Rift Valley	West Pokot Baringo Samburu Narok Kajiado	Chepareria, Kishaunet, Orolwo Tangulbei, Nginyang, Loruk Maralal town, Suguta, Baragoi, Lolkuniyiani, Lolkuru, Ilpus Suswa, Mulot Ewaso Kedong
Coast	Tana River	Garsen, Waldena

These NLMIS trainings elicited overwhelmingly positive responses among workshop participants. Discussions on support for data gathering and information dissemination were carried out with various agencies in the districts visited, including the Ministry of Livestock and Fisheries Development (MoLFD), Arid Lands Resource Management Project (ALRMP), District Livestock Marketing Councils (DLMC), Food for the Hungry International (FHI), Food and Research Management (FARM)-Africa, North Eastern Pastoralist Development Programme (NEPDP), CARE-Livestock Marketing Enterprise (LIME), Oxfam GB-Wajir, Millennium Village Project, and the Provincial Administration.

Major Findings

Out of the 31 markets visited, 19 (61%) were already within the NLMIS network, while in four others (13%) the infrastructure for mobile network connectivity was under construction (at the time of writing this brief the system is now operational). The eight markets (26%) that are yet to be networked include Kotile, Tangulbei, Nginyang, Loruk, Baragoi, Ilpus, Ewaso Kedong and Waldena. The team observed that following introduction of the NLMIS to the districts visited over a year earlier, data collection and uploading were proceeding smoothly in the markets networked. Moreover, a large number of people, both at the offices and in the markets, were aware of the system and were able to download the information. However, for many people, regular use was hampered by constraints in dissemination, including the lack of sharing of information by the district livestock teams. Some stakeholders were still unaware of the system, or unable to download the information. The team stressed the importance of working together and disseminating information for the benefit of both producers and traders so as to improve the livelihoods of the pastoralists. In addition, the district teams all cited general limitations in information dissemination due to the large areas covered by the pastoral districts, the poor road network, low mobile phone coverage, and lack of knowledge of the best media to use for various communities. It is apparent that traders and brokers had an undue advantage over producers when it comes to knowledge of prices in different markets. This is attributed to the traders use of wide networks that connect primary, secondary and terminal markets, most with access to information communication technology such as mobile phones. For producers, access to information is limited since they do not have absolute access to markets, let alone information communication infrastructure. Many cases were observed where traders coming from other areas first sat together to agree on prices they would offer to livestock owners, with a general disinterest in dealing with informed sellers; they would often bypass those with information and go to those they knew were less informed about prices outside their local markets. It is increasingly evident that producers need to organize in order to counteract these manoeuvres.

Challenges and Lessons Learned

Livestock producers are participants in a world that is fast accelerating along the information superhighway, where access to mobile telephony and internet capacities are helping to alleviate isolation of rural producers and link them closer to initiatives that contribute to development (Kariuki and Kaitho, 2006). In implementing the NLMIS, there were a number of challenges encountered and lessons learned. Among these are that initial system start-up costs (servers, computers, mobile phones, bandwidth, e-mail, telephone calls, programming, trainings and field travel) are high, while running costs (airtime, replacement of phones, incidentals) are modest. Markets cannot be selected at will

as it depends on their importance as supply nodes, interest and support of stakeholders, availability of personnel to collect and report the data, and access to mobile phone network coverage. Turnover of staff also affects consistency in the flow of data.

The diversity of animal breeds, age classes, size, and body condition all present challenges in identifying which animals to select for representation. For some markets, the accuracy of aggregate supply of livestock offered in the market on a monthly basis is not assured given that the reporting is done only once a week, and the numbers should therefore be considered as indicators rather than absolute figures. Furthermore, it is possible that some animals are transacted more than once before leaving the market giving a variation in the selling price. However, on average, most animals are transacted only once, as sampling is by dominant breed/class/age/grade combination and the calculated average price is therefore a good representation of the price for that particular market day.

In some markets, development may not always be achieved due to limitations engendered by conflict and the fragmentation of markets based on ethnic considerations leading to emergence of mini-markets within the larger market. This also affects the use of infrastructure and facilities developed for the market, which may remain unused.

In terms of access to information, traders and middlemen have a competitive advantage over producers. This is because livestock trade is highly dominated by middlemen who provide brokerage services and handle most of the transactions on behalf of producers, many of whom hardly venture into the market, making it difficult to reach out to them during regular trainings conducted at the market level. Their knowledge of market dynamics is therefore greatly curtailed, and this is compounded by their limited access to information due to low levels of literacy, limited network coverage, and limited access to other channels of information such as the Internet. There also exists a large divide between traders/middlemen and producers in terms of spatial location, temporal difference, access to resources, knowledge, and often deliberate distortions in market information that favors traders and middlemen. Producers are often far removed from key markets resulting in temporal delays in getting information and limited knowledge on markets outside their immediate locality. It takes time and effort to change people's behavior and attitudes, and people continue to rely on traditional communication methods that are low in speed, reliability and efficiency.

At the macro-level, marketing of livestock is not given prominence compared to that of agricultural commodities, a situation compounded by poor infrastructure and lack of up-to-date policies to support the business.

Practical Implications

It was agreed that the open-air approach used in the trainings helped break some barriers in terms of getting access to livestock producers and sellers who do not have good access to market information. Developing the technical and human capacity to meet market information needs and decision support for livestock producers helps to bridge the gap between markets on the one hand, and producers on the other. This allows producers to make better choices on where to sell their animals and creates leeway to have stronger bargaining power with traders, which translates to improved returns to their marketing transactions, and therefore an enhancement of their economic status. Research has shown that on average, producers receive only about half of the terminal market prices in Nairobi (Agrisystems, 2003), while traders reap proportionately higher returns. A marketing information system can lead to changes in marketing behaviour, while understanding market signals can play an effective role in orienting producers towards market opportunities (Ferris, et al. 2008). If the system can inform producers so that they can negotiate for better prices, then it will have achieved its primary objective.

If producers get better returns, the cash generated meets expenditure for goods and services that they cannot produce at home. This not only helps them to improve the livelihoods of their households but also creates demand for goods and services in the local and national market arenas. Socially it means that information can be targeted to reach specific gender, age, and wealth categories to reach a wider range of clientele, which helps producers to form and strengthen marketing associations and pool resources to invest in marketing that enables them to reduce per capita transaction costs.

Finally, to enhance the impact of the National Livestock Marketing Information System on communities of livestock producers, agencies also need to focus more on demonstrating and helping people to better understand the link between drought and changes in livestock prices, as part of early warning and contingency planning to assist in saving livestock assets during periods of emerging crises. While the LEWS technology embedded within LINKS and the NLMIS provides the toolkit, the agencies must simply enable the implementation.

Concluding Remarks and the Way Forward

The NLMIS is part of the vision for the development of pastoral livestock producing areas; through improving information flow to livestock producers and traders, they become equipped with the knowledge to make better choices on livestock marketing, during both normal and distress periods. This model can be applied to collect,

report and analyze data, and also to disseminate information on animal diseases, water resources situations and conflicts over resources. To move the system forward, there must be commitments for long-term financing through a combination of public (Ministry budget line) and private investment. The media can play a role in facilitating dissemination of information generated by the system, and mobile telephone operators can explore ways of contributing to the system through support in sending data and accessing information.

To enhance decision making in livestock trade, it is useful to integrate livestock market information with other information such as disease outbreaks. Besides infrastructure development (roads, water, abattoirs, communication networks), there is a need for a clear policy favorable to the development and use of information communication technology (ICT) particularly in livestock related activities. The proposed concept of digital villages, villages linked by ICT, should address the special needs of poor, small scale and remotely located livestock producing communities who are far removed from hubs of economic activity in time and space.

Other required interventions include continuation of the work in the remaining markets, increased support by local authorities, expansion of mobile network services and support to data gathering, processing and analysis, as well as information dissemination to feed into a livestock early warning system (Republic of Kenya, 2006). Networking markets with headquarters will allow easy access to information, while involving local institutions in developing training modules for users will enhance acceptability and confidence in the use of the technology.

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GLOBAL LIVESTOCK CRSP

Factors Influencing Beef Cattle Marketing Behavior in Pastoral Areas of Kenya: The Role of Livestock Market Information

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LINKS Project

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Marketing transactions take place in an environment where information is shared and exchanged among and between sellers, buyers and middlemen. It is argued that traders and middlemen have a competitive advantage over producers in negotiating for prices, because the former have access to prices in both primary and terminal markets, while the latter only have limited access to prices in the primary markets. This Research Brief highlights the situation regarding access to livestock marketing information by producers in pastoral markets of Kenya. Results show that livestock marketing information was not accessible to producers from September 2004 to September 2005, and hence did not play a significant role in influencing market prices. Subsequent analyses also show that producers consider a number of attributes when pegging prices to their animals, and that these tally with the categorization system developed by the Livestock Information Network and Knowledge System (LINKS) project. Further findings suggest that past efforts to develop livestock marketing information systems have been dogged by limited capacity to provide information that is accurate, timely, reliable, and spatially coherent. This has been exacerbated by failure to effectively use existing media and complement these with emerging information communication technologies to disseminate the information. LINKS has since responded to these factors through improvements in geographical coverage, accuracy, reliability and timeliness in the overall livestock market information system, as well as through improved information dissmination systems; improvements that have strenghted LINKS, allowing it to function as the foundation for the National Livestock Marketing Information System in Kenya.

Background

Research has shown that livestock marketing information plays a significant role in improving the performance of pastoral production and marketing systems (Ndikumana et al. 2000; Aklilu et al. 2002; Mbogoh et al. 2005). More timely, accurate and reliable livestock information can lead to increased commercial livestock offtake and increased producer prices. These studies (ibid) hitherto have focused on the broad aspects of livestock markets in Kenya. Very little attention, however, has been given to examining specific aspects of livestock markets, such as what constitutes viable livestock marketing information.

This study was undertaken to analyze the factors that influence beef cattle marketing behavior in pastoral areas of Kenya, with emphasis on the role of livestock marketing information. For instance, although traders have indicated their considerations for some quality attributes in beef cattle sold in pastoral areas, these are not well documented. Moreover, there have been no precise estimates to quantify the value of these attributes. Specifically, the present study consists of three main components: 1) Identifying the existing sources of information and extent of their use by producers; 2) Identifying the physical attributes of beef cattle considered while selling animals; and 3) Evaluating the importance of these attributes in determining prices of animals offered for sale.

Information derived from the study will provide inputs to designers of livestock marketing information systems to improve their information formats to make them more effective and efficient in terms of having the capability of transmitting relevant, accurate, reliable, accessible and useful information. In addition, it provides information on attributes of beef cattle that are demanded by traders, an important factor in livestock marketing for pastoralists, should they have to respond to the needs of the market.

Methods

The study used two sets of data. The first set was sourced from a cross-sectional survey conducted using a questionnaire administered to 135 pastoral households from Garissa and Isiolo Districts. The second set was a 1,233 transactional survey data set collected between September 2004 and September 2005 from three livestock markets in Kenya: Nairobi, which is the main terminal market in Kenya, and two other pastoral markets (one in Garissa in the northeastern rangelands and one in Isiolo in the eastern rangelands). The samples

Table 1. Ranking of beef cattle attributes by respondents.

Attribute	Description	Rank	Respondents (n=132)	Percentage
Sex	Animal is male or female	1	131	94.9
Age	Immature (< 1 year), young (1-2 years), mature (>2 years)	2	109	79
Body condition	Muscle and fat distribution	3	100	72.5
Castration condition	Male castrated or not	4	58	42
Breed	Boran, Zebu, Sahiwal, Mixed	5	48	34.8
Breeding ability	Reproductive ability	6	32	23
Character	Aggressive or docile to people and other animals	7	21	15.2
Lactation	Level of milk production and milking length	8	18	13
Pregnancy status	Female in-calf or not	9	16	11.6

were based on beef cattle presented and sold in the three markets. The data were collected randomly in each of the markets by trained Livestock Information Network and Knowledge System (LINKS) project market monitors. The monitors visually assessed the beef animals on different characteristics, and interviewed traders on market transaction prices. The raw data were used to calculate the average prices, which were then sent to the LINKS central server via coded Short Message Service (SMS).

Preliminary Findings

Data from the cross-sectional survey were analyzed using descriptive statistics to generate frequencies. Results indicated that a majority of the respondents (73%) had access to radio, while 28%, 11% and 10% had access to a cellphone, newsprint and television respectively. To obtain information on livestock marketing, 75% of the respondents relied on their neighbors and their own personal visits to the market. On the need for price information from other markets, 77.8% of the respondents expressed a strong need, and out of these 32%, 54%, and 9% desired to have the information on weekly, monthly and quarterly basis respectively, while 5% were indifferent about the frequency. A total of 96% of the respondents preferred to sell their animals within markets in their region citing distances to other markets, security, volume of sales and unfamiliarity with distant markets as the major factors influencing the decision, in that order. The study found out that over 75% of the pastoral households used visual assessment to peg prices to their animals before sale. This corroborates findings in Kaitho et al. (2004). As a follow-up step, pastoralists were asked to rank the attributes they considered when selling beef cattle. Table 1 summarizes these results by frequency.

The results from the transactional data, analyzed using regression analysis, are given in Table 2. Almost all the attributes were negatively correlated to the price, class, sex, volume, castration, grade and market. Other reported items, such castration and breed type were not significant. This could have been associated with the uniform/single breed available in each market. The analyses for the individual attributes indicate the relationships given below.

Class. The class of beef animal was used as a proxy for age (mature, young, immature), which showed that mature animals fetched higher prices than immature ones. The coefficient for class variable suggested that class had the largest negative influence on cattle price as indicated by the highest negative coefficient. Price decreased by 0.53% for a 1% change in class.

Sex. The results on the sex variable (male, female) showed that males fetched higher prices than females by a premium of 0.4% on average. This corroborates results of previous

studies by Sieff (1999) which showed that males usually fetched higher prices than females. The positive correlation coefficient observed for sex showed preference for males. Males are bought for both breeding and slaughter purposes. Their demand was expected to exceed that of female cattle, which are mainly required for breeding purposes. Males were also thought to yield more meat than females.

Market. The market variable has a negative coefficient (-0.149) and standard error of 0.012. The negative coefficient indicates that prices in Nairobi are higher than prices in other markets of Isiolo and Garissa. This is reasonable given that Nairobi is the terminal market.

Grade. The variable grade (grade 1, 2, 3, 4; the higher the grade, the poorer the body condition) is used to reflect the influence of the cattle body condition scoring method (a proxy for meat quality and weight) as developed by LINKS, and emerged as a significant explanatory variable. It has a negative coefficient (-0.147) with a standard error of 0.009. Animals available for sale in the markets were mainly grades 2 and 3. Grade 2 fetched a higher price than grade 3.

Volume. Volume was the other factor affecting prices. The volume had a standardized coefficient of -0.235. This corroborates well with the theory of standard demand which states that the lower the supply (volume) the higher the price. In this case it indicates that a 1% increase in volume decreased the average price by approximately 0.235%.

Breed. The breed variable (Boran, Zebu, Mixed) had a positive coefficient of 0.037and standard error of 0.010. This indicated that mixed breeds (crosses) commanded higher prices than the local breeds such as Boran and Zebu.

Castration. Castration yielded a negative coefficient, –0.026 and standard error of 0.016. This implies that non-castrates fetched higher prices than castrates because they were in high demand both for breeding as well as slaughter purposes and were therefore regarded as premium animals. The results, however, were not significant at the 1% level.

The overall regression model explained about 82% of the total variation in the dependent variable. The regression model on factors influencing commercial offtake rates showed that market information had a positive response to livestock offtake rate; the response was significant at the 10% level with a coefficient of 0.074 and standard error of 0.007. Other significant variables determining offtake rate were household size, dependency ratio, cattle birth rate, cattle purchase rate, off-pastoral income and mortality rate. At the time of the study, market information provided by LINKS had just started diffusing to producers, and respondents felt that improved accuracy and reliability of market information would be useful for informing marketing decisions for pastoral households. Research findings (Aklilu et al. 2002; Mbogoh et al. 2005) show that information can indeed improve marketing performance in pastoral areas if it can be availed efficiently and in good time.

Practical Implications

The results indicate that livestock marketing information was not accessible to producers from September 2004 to September 2005, and hence did not play a significant role in influencing market prices. Subsequent analyses also show that producers consider a number of attributes when pegging prices to their animals, and that these tally with the categorization system developed by LINKS. LINKS has since responded to these factors through improvements in geographical coverage, accuracy, reliability and

Table 2. Regression results of the semi-log price model for beef cattle.

X	Variable	Unstandardized Coefficients		Standardized Coefficients	
		Beta	Std. Error	Beta	T value
	(Constant)+	10.17	0.07		151.04
1	Market+	-0.15	0.01	-0.19	-12.11
2	Class+	-0.53	0.01	-0.69	-42.23
3	Breed+	0.03	0.01	0.04	2.59
4	Volume+	0	0	-0.24	-14.39
5	Sex+	0.40	0.07	0.09	6.02
6	Castration	-0.03	0.02	-0.03	-1.69
7	Grade+	-0.15	0.01	-0.25	-16.86

Dependent Variable: Natural log of price
+ Significant at 1% level, R2 = 0.821

timeliness in the overall livestock market information system. Therefore, the challenge to develop a flexible, demand-driven system that is easy to maintain and that allows the input of contents with maximum efficiency as envisaged by Kaitho et al. (2004) is right on course. The integration of this system in livestock markets across Kenya will provide a national livestock marketing information system (NLMIS: see Kariuki et al. 2008) tailored to meet the needs of livestock producers. Dissemination of information through media that are easily accessible to most producers will enhance information flow to pastoral communities, eliciting the desired response in livestock marketing. It is therefore prudent to explore ways of using the existing delivery media, such as the popular radio broadcasts and the growing mobile telephony and Internet gateways across most towns in the remote areas of Kenya, to accomplish this feat.

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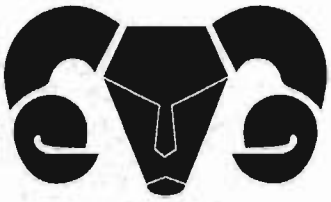
Edited by David Wolking & Susan L. Johnson

GLOBAL LIVESTOCK CRSP



Deteriorating Terms of Trade and Food Security Among Pastoral Livestock Producers in Kenya

Gatarwa Kariuki, International Livestock Research Institute;
and Robert Kaitho, Texas A&M University
LINKS Project

Research Brief 09-03-LINKS April 2009

Over 80% of Kenya's land mass of 58.3 million hectares is classified as arid and semi-arid lands (ASALs). In spite of the unfavorable weather conditions, the ASALs make a significant contribution to the country's agriculturally driven economy, by supporting more than half (52%) of the livestock population geared primarily towards the production of beef. Households practicing pastoral livestock production experience a myriad of problems including drought, poor infrastructure for communication and marketing, low incomes and food insecurity. With changes in lifestyles and decreasing capacity of livestock to provide for their basic needs, these households are increasingly dependent on the market for their non-livestock-based food and non-food needs. Their purchasing power is dependent on income levels, economic conditions and the terms of trade between livestock and cereals, all of which change over time. This study investigated terms of trade for pastoral livestock producers in Kenya, finding that the price of maize has risen much faster (about twice) than that of livestock, diminishing the purchasing power of livestock keeping households, and thereby eroding their terms of trade. The emergence of these unfavorable terms of trade has in turn eroded their capacity to meet basic needs and compromised their food security situation and overall socioeconomic welfare, resulting in significant increases in the demand for relief and food aid at a major cost to government relief funds and development agencies. Through market information systems like LINKS, however, the provision of market information can equip planners and policy-makers with the tools to track price trends and enhance decision-making and the development of appropriate interventions aimed at mitigating the effects of these deteriorating terms of trade.

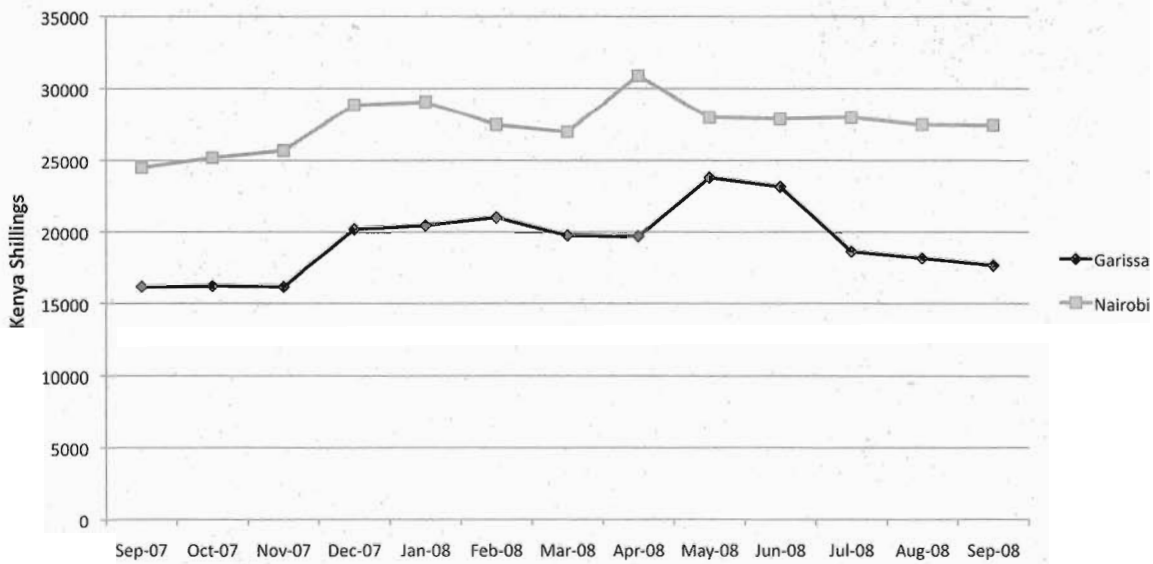
Background

Kenya's livestock sub-sector contributes about 10% of the country's Gross Domestic Product (GDP), accounts for nearly 50% of the agricultural sector's GDP, and is the main source of livelihood for the people in the arid and semi-arid areas (ASALs) of Kenya (Republic of Kenya, 2006). The sub-sector accounts for 90% employment and more than 95% of family incomes in these areas. The ASALs are home to nearly 30% of the country's human population of an estimated 35 million people, and holds over 50% of the country's total livestock, which is estimated at 26.9 million chicken, 9.5 million beef cattle, 3.5 million dairy and dairy crosses, 13.9 million goats, 10 million sheep, 930,000 camels, 716,000 donkeys, and 320,000 pigs. The ASALs are also the major producer of beef, estimated at 320,000 metric tons (Republic of Kenya, 2005). The kinds of animals kept by producers in these areas are comprised of indigenous, exotic and cross breeds.

Livestock keeping communities rely on their animals for subsistence and cash to buy other food and non-food items. Since pastoral communities do not engage in agricultural production, they need to exchange their livestock in the market to generate the cash needed. The terms of trade between livestock and cereals have important implications for food security at the household level. Maize is the most commonly traded and consumed cereal grain among many communities in Kenya, and the price is used as an indicator of terms of trade. Pastoral communities have either to buy maize from the market, or access it as relief food provided by government or humanitarian agencies. Understanding markets in pastoral areas is key to addressing food security and development issues in arid and semi arid areas of Kenya (Ochieng, 2006).

Methodology. LINKS, in collaboration with the Kenyan Ministry of Livestock Development and Kenya Livestock Marketing Council, has developed a suite of technologies that have been adopted as the national livestock market information system (NLMIS: see Kariuki et al. 2008) for Kenya. The system is now collecting and reporting data on livestock prices from 18 markets. The market monitors collect data on a designated day of the week from a sample of five animals of each kind/breed/age/sex/grade combination, after which they calculate the average figure for that market day. The analysis presented here is for Garissa and Nairobi markets for the period beginning September 2007 to September 2008. Garissa market, located about 400 km to the north of Nairobi,

Figure 1. Price trends for Boran cattle in Garissa and Nairobi markets.



is the largest market for Boran cattle, the dominant breed in northern Kenya. The market is held on Wednesday every week. Nairobi, the capital city and major livestock terminal market, has three markets (Njiru, Dagoretti and Kiamaiko), all of which operate on a daily basis (except Sundays) to supply meat for the large urban population both in the city and the peripheral suburbs. Live animals are transported from Garissa by truck and offloaded at the Nairobi markets, where they are taken directly to slaughter. Njiru market receives mainly Boran cattle from northern Kenya, while Dagoretti receives Zebu and mixed breeds of cattle from the southern and western parts of Kenya, and Kiamaiko receives small stock from throughout Kenya. Prices of maize have been obtained from the Regional Agricultural Trade Intelligence Network (RATIN), which collects and reports monthly prices for maize, beans and rice in Kenya, Uganda, Tanzania and Rwanda. Prices of maize are reported in USD per metric ton, and were converted to Kenya Shillings (Ksh) per kilogram using currency exchange rates obtained from the Central Bank of Kenya for the period September 2007 to August 2008.

Major Findings

Garissa market receives an average of 2,000-3,000 animals per market day, and remains the largest source of animals to the Nairobi Njiru market. The trend in prices for Garissa and Nairobi markets is depicted in Figure 1. On the supply side, the graph shows that livestock prices in pastoral areas tend to peak from April to May, and November to December, when there is quality forage due to prevailing good rainfall conditions and when pastoralists subsequently minimize sale of animals. On the demand side, livestock prices go up in December and April associated with the festive Christmas and Easter seasons, when the demand for meat rises especially in the urban areas. During the period under consideration (September 2007 to September 2008), there was a general increase in livestock prices with the average price of mature Boran cattle increasing by 9.3% from Ksh 16,200 to 17,700 in Garissa, and by 12% from 24,500 to 27,450 in Nairobi. The price in Nairobi was on average 44% higher compared to the price in Garissa. The cost of hiring a 10-ton lorry with the capacity to carry 18-20 cattle has risen by 20% from Ksh 25,000 to 30,000, due to the recent increases in fuel prices (an increase of over 30% in eight months during the study). Other costs associated with livestock marketing include movement permits, and loading and storage fees.

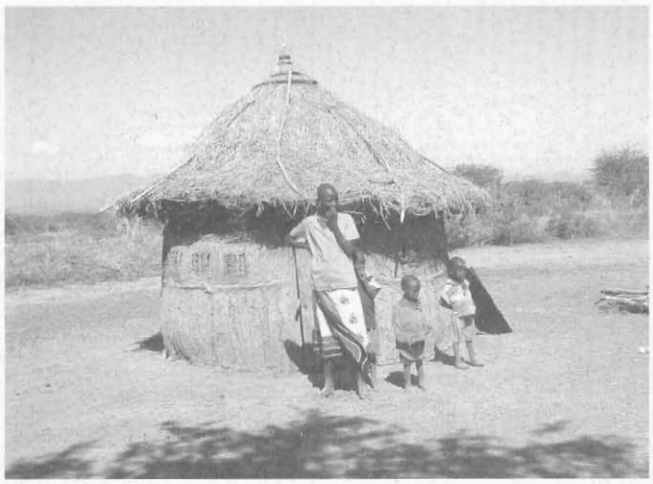
The cost of beef in major urban centres has increased by 37.5% from Ksh 160 to 220 per kilogram. The average price of Somali goats has increased by 30% from Ksh 2,360 to 3,060 in the Garissa market. The cost of transportation has increased faster than the increase in livestock prices, implying reduced margins for traders. During the same period, the national average price of maize increased by 61% from Ksh 13.50 to 21.70 per kilogram (RATIN, 2008), while current prices vary from Ksh 21.70 in Nairobi and 25.40 in the Busia market, located at the border with Uganda. The fact that maize has to be transported to pastoral areas resulting in a considerable time lag means that the price of maize will be much higher in those areas. In addition, maize may not be available at the place and time it is required, given the vast expanse covered by the pastoral areas and the lack of adequate infrastructure to facilitate the smooth and fast flow of goods.

Practical Implications

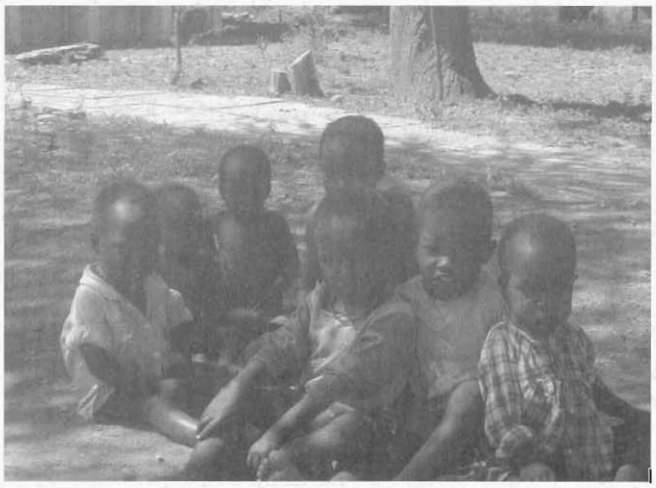
Pastoral households do not produce their own maize. Therefore, structurally poor households are heavily dependent on food donations. For those who depend on the market, they require purchasing power and food availability, a difficult reality given the logistical complexities of supplying food at the right time, price and quantity in local markets. This study shows that the price of maize has risen much faster (about twice) than that of livestock, diminishing the purchasing power of livestock keeping households, and thereby eroding their terms of trade. The effect on pastoral households is severe: a household may need to sell twice as many goats as they used to sell to buy the same amount of food. This situation is compounded by the fact that during the dry seasons, livestock prices tend to fall, while cereal prices rise. This leads to increased food insecurity for livestock keeping households and at such times, the delivery of relief supplies and food; a mass mobilization of resources expended by government and humanitarian organizations.

The logistics of distributing this relief food are demanding and expensive. In addition, the demand for energy (kerosene) to cook the food (primarily maize) increases, driving up fuel prices and resulting in increased pressure on environmental resources to provide water, fuel wood and charcoal; pressures leading to further land degradation.

The provision of market information such as practiced by LINKS and RATIN equips planners and policy makers with the tools to track price trends that can help to improve decision-making and devise appropriate interventions that mitigate the effects of deteriorating terms of trade for pastoral households. A marketing information system can also lead to changes in marketing behaviour, while understanding market signals can play an effective role in orienting producers towards markets. Such a system serves to inform producers so that they can negotiate for better prices for their livestock. If producers get better returns, the cash generated meets expenditures for goods and services that they cannot produce at home, including non-animal source foods, along with the opportunity to improve their skewed terms of trade. This not only helps them to improve the livelihood and health of their households, but also creates demand for other goods and services in the local and national market arenas, thus promoting trade and economic growth.



A mother and her two children stand outside their hut in Ngambo, Kenya. Pastoral households like these do not produce their own cereals, and therefore are heavily dependent on external markets for maize, as well as food donations in time of stress. This dependency leaves pastoral households vulnerable to cereal grain price increases and jeapordizes their overall food security. Photo by Christopher Barrett.



A group of malnourished children rest in the shade near Marigat, Kenya. Deteriorating terms of trade for pastoralists undermine efforts to enhance child nutrition, livelihood, and health. A household today may need to sell twice as many goats as they used to sell to buy the same amount of food. Photo by Christopher Barrett.

Further Reading

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Edited by David Wolking & Susan L. Johnson

GLOBAL LIVESTOCK CRSP

Changing Livelihoods, Risky Environments: Social and Economic Change among Pastoralists in East Africa

John G. McPeak, Syracuse University; Peter D. Little, Emory University; Cheryl R. Doss, Yale University; Christopher B. Barrett, Cornell University

Research Brief 08-01-LiTEK March 2008

We are currently working on a book with the provisional title above. It summarizes our findings from our work with the GL-CRSP Pastoral Risk Management (PARIMA) project. This brief outlines the aim of the book, the approach in writing it, and the key findings that have emerged. The final volume is expected to be published in 2008. The book focuses on providing insights into how livelihood strategies operate currently and how they have changed over time in pastoral areas. We do this by placing the empirical evidence we gathered in the context of the research conducted previously in the PARIMA area. We do find livestock remain central to people's livelihoods, but also document other important sources of income that both reduce poverty and vulnerability to poverty. We present evidence on how people view the risks they face and their priorities for future development in their community. Importantly, we collected information from multiple sites, multiple households within a site, and multiple individuals within households, so we are able to identify patterns that are generated by inter community, inter household, or intra household differences.

Background

Given pastoralists' centrality to many environmental, security, economic and humanitarian concerns in Africa, there is a critical need for donors, policymakers and other researchers to obtain a detailed understanding of contemporary pastoralism. We draw on a decade of in-depth, interdisciplinary research in multiple ethnic communities across a broad swath of Ethiopia and Kenya to offer an unprecedented, evidence-based, nuanced perspective on contemporary pastoralism in east Africa. The core of the evidence on which we draw was generated by intensive fieldwork from 1997-2006 in six sites in northern Kenya and five sites in southern Ethiopia. These areas suffered the El Niño floods of 1997-98, a severe drought in 1999-2000, and a major drought again in 2005. In between, they enjoyed periods of recovery while coping with changing policies and project interventions and a constantly changing market environment. This field research platform provides in depth insight into how pastoralists manage the myriad risks they face, at individual, household and community levels and how they choose and adapt livelihoods to make the best of their existence on the ecological, economic and political margins of these two nations. We contextualize the evidence from our recent fieldwork within the broader historical record on pastoral practices in this area in order to identify emerging trends, and to stress how development policies could encourage the beneficial trends we find while addressing emergent negative trends. This book thus not only expands the research base on pastoralism, it also has important implications for policy at local, national and regional scales and touches on a range of issues central to international development studies more broadly.

Missing from current literature and policy discussions is a sense of what pastoralism actually looks like across the full bust-and-boom cycle, how it has adapted past practices and institutions, and where it is likely headed in the future. How do pastoralists respond to the risks they face, including but not exclusively to crisis events, and how has this changed over time? What are they doing in non-crisis periods, and how has this changed over time? Do different types of households have different livelihood responses and, if so, why and with what consequence for their and others' well-being? To what degree do individuals within households (for example, wives, sons, and daughters) experience or perceive life in the arid and semi-arid lands (ASAL) differently? Who are the success stories within pastoralist communities and what has allowed them to create adaptable and successful livelihoods?

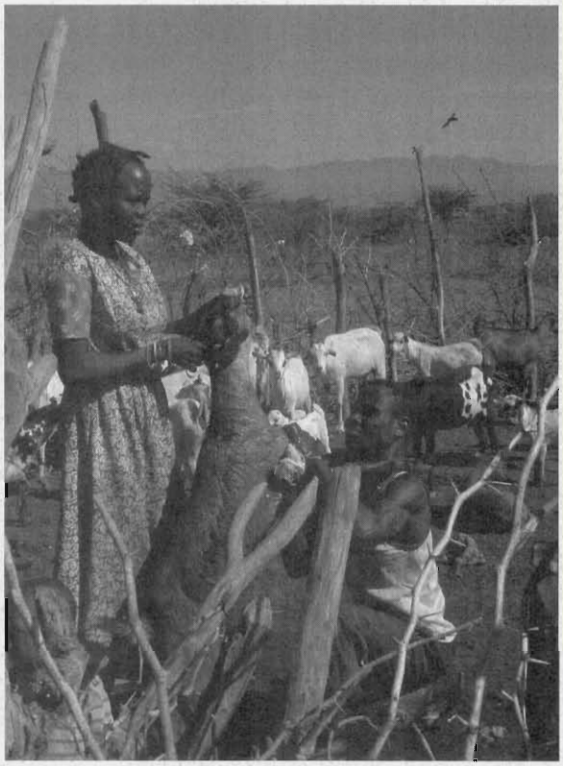
This book is the first interdisciplinary attempt to document how pastoralists and their communities have responded to an increasingly risky environment marked by climatic disturbances, armed conflicts, liberalized markets and politico-economic instabilities. We do so without losing sight of the fact that these are important but infrequent events in the lives of the pastoralists and argue there is much to learn from understanding the pastoralists' adaptations to change and their behavior in non-crisis periods that draw comparatively little attention.

People, Livestock and Risk

The book's main premise is that notwithstanding the considerable, multidimensional risk pastoralists face, livestock are and will remain the foundation for livelihoods in the region for the foreseeable future. Animal husbandry represents the most economically efficient use of East Africa's rangelands and is thus a crucial element of any viable strategy to support the livelihoods of the tens of millions of people in the ASAL areas in Ethiopia and Kenya. Consequently, pastoral risk management today is about how herders can cope with increased economic and environmental pressures without jeopardizing their key non-human asset, livestock. The evolving strategies for accomplishing this and their tensions and contradictions are key subjects of this book.

While livestock are fundamental to the economy and cultures of the east African ASAL, however, the region's people are our focus. This reflects pastoralists' clearly expressed prioritization of basic human concerns – food security, education, health – ahead of livestock or other livelihood concerns. Despite considerable and costly interventions in marketing, range management, wildlife conservation and food aid over the years, our research shows most pastoralists favor interventions that address basic human needs: access to safe water, health care, and education. This finding has important implications for development programs, especially those that claim to focus on the needs and priorities of pastoralists. The high demand for the provision of basic human services shows just how marginalized pastoral areas remain in terms of public service provision and infrastructure. Although livestock are central to pastoral systems, they are of distinctly second-order concern behind elementary human needs.

The book's core strength arises from the rich empirical base we use to document patterns of well being and inequality in the study sites, the emergence of new livelihood strategies, marketing patterns and mechanisms and institutions for managing risk, intra household variation in well being and perceptions based on differences in gender and status, and other important topics. We collected detailed, longitudinal data that we use to develop our arguments, and present our analyses of pastoral economies and institutions at individual, household and community levels. The core of the data is individual level survey data collected quarterly over the period of 2000-2002 that followed up to three individuals in each of 30 households in each of eleven communities in the region. These individuals were interviewed annually from 2004-2006. In addition, survey data at the community level was collected monthly. This quantitative survey data combined with qualitative data collected throughout the region during this period provides an opportunity for analysis at numerous levels. While due attention is given to larger macro-structural and political contexts, the work largely concentrates on understanding and explaining micro-economic and social behavior under conditions of risk and uncertainty.



Treating sheep in East Africa. Photo by Chris Barrett.

Other important features of the book further distinguish it from previous contributions. First is the book's spatial and cross-cultural coverage. Unlike most social science sources on East African pastoralists, this study covers several different ethnic groups, and its spatial scope extends well beyond a limited set of communities. This approach allows for generalizations about social and economic processes that are not possible with case studies of individual groups and communities regardless of how richly detailed and insightful they are. The northern geographic boundary of our study area is about 130 km north of the Ethiopia/Kenya border. The southern boundary is in north-central Kenya about 200 km north of Nairobi. The study region covers approximately 125,000 km^2 and includes several different ethnic groups – the Il Chamus, Rendille, Samburu, Ariaal, Boran, and Gabra in Kenya, and the Boran, Gabra and Guji in Ethiopia – spanning a range of livelihoods, from agro-pastoralism to more specialized pastoral systems. It also spans agro-ecologies, from semi-arid (650 mm/year) to very arid (150 mm/year). Some of these communities have some access to livestock and labor markets and to public services, while others have almost no access to markets. Consequently, we can compare and contrast emerging livelihood strategies across a range of cultural, market, and agro-ecological conditions.

Second, the book presents longitudinal data to capture both drought and post-drought periods over a ten-year period, 1997-2006. The detailed local economic and social data

demonstrate how shocks affect wealth accumulation and welfare, reducing some household herd sizes to low levels from which pastoral recovery is very difficult without external resources. While other accounts focus on crisis events themselves, rather than on the human actors, we document how local populations actively responded, often in extremely innovative ways, to a succession of different shocks. They commonly employ different economic and social strategies that often supplement rather than replace their main livelihood of extensive livestock production. Many strategies attempt to balance the cash demands of the modern market economy with the spatial and seasonal demands of mobile animal husbandry.

Third, because the study employed a random household sampling technique based on local administrative units in Kenya and Ethiopia, it includes many communities of former pastoralists who have now settled in the region. By including these people in our study, we gain considerable insights into the dynamics of poverty and economic change in the area. Many studies of East African pastoralism concentrate only on those who still actively herd semi-nomadically and avoid communities of settled ex-pastoralists which, ironically, are the fastest growing segment of the population in some pastoral locations. The livelihood strategies of ex-pastoralists and settled populations differ in important ways from those of mobile pastoralists and are thus crucially important to understanding the pastoral economy and to designing appropriate development policy for the region.

The Kemise Cattle Market, Ethiopia. Photo by Peter Little.

Fourth, by systematically collecting data at multiple scales, we cannot only make comparisons across communities, but also we can explore the behaviors and well being of different households within communities and of different individuals within households. Pastoralists are too often treated as a homogeneous mass of peoples and places. Our analyses reveal striking heterogeneity, especially over time and space, but also among households within specific pastoralist communities and, in certain dimensions, among individuals within households. We can consider gender issues both by comparing male and female-headed households and by looking within male-headed households to understand how the status within households affects both men and women. Such analytical detail is important in targeting policy and project interventions as well as in understanding the diverse experiences of common phenomena.

Policy Relevance

Ultimately, this book thus offers not just an unprecedentedly detailed, nuanced and broad perspective on pastoralism as a subject unto itself. It also permits us to speak, indirectly and directly, to several contemporary global debates of consequence.

Poverty Reduction. This book makes a critical distinction between poverty in pastoral areas and poverty among those practicing pastoralism. It also offers rare documentation of the dynamics of poverty for households throughout the region during periods of drought and recovery that contribute to an understanding of the complexities of poverty and social and economic change in pastoral East Africa and inform policymaking and project programming for some of the poorest populations on earth.

Humanitarian versus Long Term Development Assistance. We provide evidence as to how aid donors might improve the effectiveness of their programs for this region, illustrate how the tension between short-term humanitarian and long-term development goals can be reduced by improved policy design, and document the way humanitarian aid impacts different groups in the study area.

Climate Variability. Although extreme climatic variability has always been present in arid and semi-arid rangelands, growing concern that climate variability is increasing with climate change raises urgent questions about how best to manage risk among poor populations. A critical first step to ensure that residents of pastoral areas can cope with existing and potentially increasing uncertainly about climatic conditions is to investigate current risk management practices and to identify policies that support the most effective of these practices.

Decentralization and Community Driven Development. Drawing on evidence from a range of cases of decentralization in land management, conflict resolution, management of marketing institutions and services provision, we find some reason for optimism regarding increased local participation in decision-making, targeting and governance. There nonetheless exist real challenges, and one must guard against

a naïve belief in the inherent superiority of local management without adequate checks in place to resolve some of the tensions and contradictions that often emerge with the devolution and decentralization of resources and decision-making authority.

Development and Insecurity. National-level institutions are generally weak and unable to effectively control banditry and violence in the ASAL areas. In addition, our study region lies perilously close to areas where the state has effectively ceased to exist and where active armed insurrections are present. We illustrate in our study how people cope with these risks and identify the challenges and opportunities when trying to improve well being in an environment where basic physical security is not guaranteed.

Anticipated Audience

This book will speak to a range of highly topical issues in contemporary international development studies and should be of interest to academic audiences in African studies, anthropology, development studies, pastoralism, range science, as well as to a wide range of practicioners in development and humanitarian organizations in sub-Saharan Africa. Rooted in evidence gathered from ASAL areas, it provides critical information that can be used by this audience in addressing the development challenges posed in the region.

Further Reading

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The Pastoral Risk Management Project (PARIMA) was established in 1997 and conducts research, training, and outreach in an effort to improve welfare of pastoral and agro-pastoral peoples with a focus on northern Kenya and southern Ethiopia. The PARIMA project is led by Dr. D. Layne Coppock, Utah State University, Email: Lcoppock@cc.usu.edu. LiTEK is a continuation of the PARIMA project as it enters the write up phase. The LiTEK project is led by Dr. John McPeak, Syracuse University. Email: jomcpeak@maxwell.syr.edu.

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Design by Susan L. Johnson

GLOBAL LIVESTOCK CRSP

How Are They Surviving Out There? An Analysis of Total Income in the PARIMA Study Sites

John McPeak, Syracuse University
LiTEK Project

Research Brief 08-02-LiTEK March 2008

One of the most commonly used measures of well being in economics is income. In our study area, special care must be taken in measuring income as much of household income is derived from the home consumption of home produced goods. This brief presents some preliminary findings on income generation patterns in the study sites when we attempt to measure total income that includes both cash income and the value of home produced and consumed goods. We find that poverty is more widespread and deep in our Ethiopian sites than our Kenyan sites. We also find that livestock remain central to income generation, and home produced and consumed milk in particular plays a prominent role in ensuring survival. Food aid is found to be an important source of income, but our evidence suggests fears of widespread food aid dependence are not warranted. Income from cropping plays a minor role, and income that comes from salary or wage labor is present in Kenya but almost totally absent in the Ethiopian sites.

Methods

We conducted surveys every three months in five sites in Ethiopia and six sites in Kenya, starting in June 2000 and ending in August 2002 (rounds below will be coded with the first two digits corresponding to the month the survey was launched and the second two digits are the year; 0600 is June 2000 and so on). Household heads were asked to report on all activities that generated cash income such as livestock sales, trade, or working for wages / salary. We also recorded information on household production in the form of milk, home-slaughtered and consumed animals, and harvested crops. For each home produced and consumed item reported, we applied the average price for the commodity observed during that time period in the site where the household resides to approximate the value of this commodity in terms of income. We also applied the market price to any food aid rations that were given to the household in the period, again using observed local market prices. Finally, we calculated the net value of any other transfer in or out of the household (cash gifts, livestock gifts, food gifts) to capture these income flows. Total income was calculated for the household for a three month period in either Ethiopian Birr or Kenyan Shillings. It was then divided by the number of members in the household reported in the survey to arrive at a per capita figure, then by 91.25 (one fourth of 365 days) to state income per capita in per day terms. To compare across countries, income data is then converted to US Dollar equivalents, using an exchange rate of 8.4 Birr and 78 Shillings to the dollar respectively. This brief presents our findings on income levels and income generation patterns in our survey area. See Table 1 (next page) for a list of the sites and site characteristics that led their selection for the study.

Preliminary Findings

Income levels. A striking feature of our findings is that the average total income per person per day in all of our Kenyan sites is larger than that calculated in the Ethiopian sites. Average per capita total income over all observations in Ethiopia is $0.12, while in Kenya the average is $0.40. As illustrated in Figure 1, there is more variation over time in the Kenyan average than the Ethiopian average, although the average total income per capita per time period is always greater than the corresponding figure for Ethiopia. The pattern of income in the Kenyan sites is likely related to the drought that gripped the area in 2000, with recovery in 2001-2002. However, the same drought hit in southern Ethiopia, yet there is much less decline or recovery noted in figure one. We can also use the total income figures to calculate some measures of poverty. Using a 50 cent per person per day poverty line, we can derive a poverty headcount index measure of 96% for Ethiopia and 75% for Kenya (at the conventional $1 per person per day poverty line the corresponding measures are 99% and 92%). A measure of the depth of poverty is the average income shortfall – how much would it take on average to bring a person below the poverty line up to the poverty line. At the 50 cent poverty line, this measure is 41 cents for the average poor person in Ethiopia and 33 cents for the average poor person in Kenya. Both in incidence and depth, poverty is more pronounced in the Ethiopian sites than the Kenyan ones, though by any reasonable measure, there is quite severe poverty in the Kenya sites as well.

The overall country averages also mask some differences across sites as illustrated in Table 2. In this table, average total income for all periods is calculated for each site, and

Table 1. Sites in the PARIMA study.

Site Name	Country	Market Access	Ethnic Majority	Agricultural Potential	Annual Rainfall
Dirib Gumbo	Kenya	Medium	Boran	High	650
Kargi	Kenya	Low	Rendille	Low	200
Logologo	Kenya	Medium	Ariaal	Medium-Low	250
Ng'ambo	Kenya	High	Il Chamus	High	650
North Horr	Kenya	Low	Gabra	Low	150
Sugata Marmar	Kenya	High	Samburu	Medium	500
Dida Hara	Ethiopia	Medium	Boran	Medium	500
Dillo	Ethiopia	Low	Boran	Low	400
Finchawa	Ethiopia	High	Guji	High	650
Qorate	Ethiopia	Low	Boran	Low	450
Wachille	Ethiopia	Medium	Boran	Medium	550

sites are ordered from highest to lowest value. The middle column reports what share of total income is accounted for by cash. The final column reports the calculated Gini coefficient for the distribution of household total income, calculated from the average household total income over all periods. A Gini index measures inequality in income, with a value of 0 corresponding to perfect equality, and 1 indicating extreme inequality.

Although there are important exceptions (Kargi and Finchawa most notably), it appears that greater involvement in the cash economy and higher total income per person per day are positively correlated (using the household level data for all periods, the correlation is 0.06 in Kenya and 0.16 in Ethiopia). It also appears that there is an ambiguous relationship between mean income and income inequality. Though not a perfect fit, it does seem that there may be a relationship between income inequality and rainfall: places with higher rainfall (Sugata Marmar, Ng'ambo, and Finchawa are the highest rainfall sites) are relatively unequal while places with lower rainfall (Kargi and North Horr are the lowest rainfall sites) are relatively equal. Explaining these patterns certainly merits further analysis.

Income Sources. Tables 3 and 4 present the sources of total income. Table 3 presents the per-period average for all Ethiopian sites, and Table 4 shows similar information for the Kenyan sites.

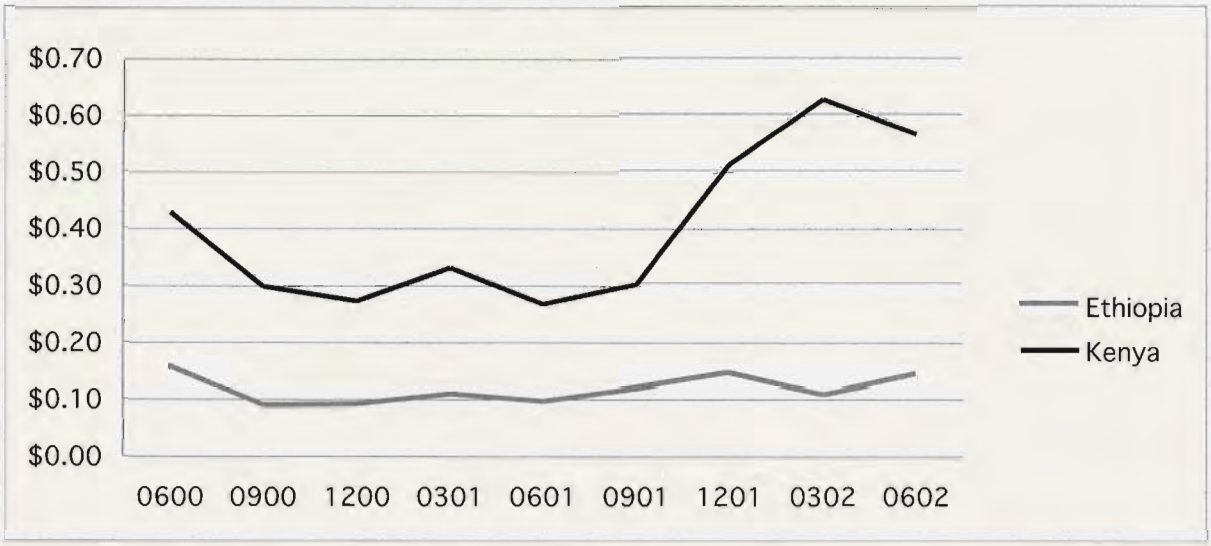
A few general impressions emerge by considering these figures. First, the livestock base of the economy is quite evident: Overall, 66% of total income in Ethiopia and 48% in Kenya comes from livestock (milk, slaughters, and sales). The figures also reveal that milk plays a critical role in income generation in these sites, as it is the largest percent contributor to income in almost all periods in both countries. Livestock sales play an important role as well, but account for a smaller share than milk. It is worth noting that crop harvests play a relatively minor role in income generation. While there are areas where cropping is growing in prevalence, these figures indicate that there is little evidence of a major shift from livestock raising to crop raising in terms of income sources.

Another message from the figures is that food aid plays an important role in generating total income, but it is not the case that it dominates income generation except in a few specific time periods. Overall, the value of food aid in total income for all periods is 23% in Ethiopia (a maximum of 50% is reached in September 2000) and 20% in Kenya (a maximum of 35% in December 2000). The first half of the data captures a drought period, and comparing all three figures it seems that food aid prevented Kenyan households from being more severely impacted by the drought and sustained Ethiopian households at a roughly equal level over time. It does not appear to be the case that food aid

Table 2. Total income per person per day by site.

	Average income per person per day over all periods in USD	Cash income share of total income	Gini measure of total income inequality
Kargi, Kenya	$0.56	28%	0.38
Logologo, Kenya	$0.50	63%	0.39
Sugata Marmar, Kenya	$0.45	62%	0.61
North Horr, Kenya	$0.34	31%	0.30
N'gambo, Kenya	$0.29	44%	0.47
Dirib Gumbo, Kenya	$0.26	41%	0.37
Qorati, Ethiopia	$0.17	9%	0.25
Dida Hara, Ethiopia	$0.16	20%	0.52
Finchawa, Ethiopia	$0.11	40%	0.48
Wachille, Ethiopia	$0.10	22%	0.25
Dillo, Ethiopia	$0.05	15%	0.34

Figure 1. Average total income per person per day by country by period.



is the sole means of supporting household through the crisis periods – rather, food aid serves as a supplement to household income generation activities. Obtaining wage and salary income is much more pronounced in Kenya than in the Ethiopian sites (14% as compared to 1% for all periods). Similarly, trading generates 9% of total income in Kenya and 2% in Ethiopia. Links to the cash labor economy and markets are clearly more developed in northern Kenya than southern Ethiopia.

Practical Implications

As noted by the income per capita per day figures, even our relatively well off sites are characterized by a great deal of absolute poverty. The incidence and depth of income poverty are more pronounced in our sites in Ethiopia than those in Kenya, though in both countries there is a case to be made based on these findings that there is a logical connection between development in pastoral areas and the overall goal of poverty reduction.

One practical implication of these findings is that livestock raising is and will almost certainly be the future foundation of the economy of these areas. Pastoral development and poverty reduction can thus be built around this core economic activity. It is notable that milk production plays such a large role in total income generation. It merits further investigation to see whether there are sustainable ways that milk production can be improved by improved feeding, veterinary care and treatment, breeding programs, or other

Table 3. Sources of total income by period in Ethiopia.

	Milk	Slaughter	Livestock sale	Trade	Wage, Salary	Non Food aid Net Gift	Food Aid	Harvest value
0600	33%	2%	17%	2%	1%	0%	46%	0%
0900	23%	1%	22%	1%	0%	1%	50%	2%
1200	37%	1%	16%	1%	2%	1%	41%	1%
0301	26%	0%	18%	3%	3%	1%	23%	26%
0601	58%	0%	16%	4%	2%	1%	17%	2%
0901	49%	1%	13%	2%	1%	2%	18%	15%
1201	65%	1%	25%	3%	1%	3%	2%	0%
0302	79%	0%	8%	3%	2%	5%	2%	0%
0602	71%	2%	11%	2%	0%	1%	4%	8%

Table 4. Sources of total income by period in Kenya.

	Milk	Slaughter	Livestock sale	Trade	Wage, Salary	Non Food aid Net Gift	Food Aid	Harvest value
0600	35%	9%	19%	7%	14%	4%	13%	0%
0900	26%	6%	15%	7%	15%	4%	27%	1%
1200	28%	4%	7%	8%	11%	5%	35%	2%
0301	32%	3%	10%	11%	13%	4%	28%	0%
0601	30%	2%	9%	14%	16%	4%	22%	2%
0901	20%	4%	11%	11%	17%	8%	26%	3%
1201	40%	2%	9%	12%	15%	4%	18%	2%
0302	45%	3%	5%	8%	14%	5%	6%	13%

type of intervention. While improving livestock marketing has received more attention recently, it may also be worth considering ways to improve milk production as well.

Another finding is that food aid dependency is not all that severe a problem. While food aid certainly plays a role in the overall income generation portfolio of people in these areas, it contributes less than they earn from other sources. Finally, connections to the cash economy do not seem to harm household income levels, and in fact are positively correlated with higher total income levels. Beneficial connections to labor markets and trade provide supplemental income streams that should be supported when possible.

Further Reading

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The Pastoral Risk Management Project (PARIMA) was established in 1997 and conducts research, training, and outreach in an effort to improve welfare of pastoral and agro-pastoral peoples with a focus on northern Kenya and southern Ethiopia. The PARIMA project is led by Dr. D. Layne Coppock, Utah State University, Email: Lcoppock@cc.usu.edu. LiTEK is a continuation of the PARIMA project as it enters the write up phase. The LiTEK project is led by Dr. John McPeak, Syracuse University. Email: jomcpeak@maxwell.syr.edu.

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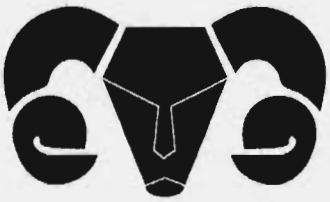

Documenting Causes of Livestock Mortality Among Pastoralists in Ethiopia and Kenya

John McPeak, Syracuse University
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Research Brief 09-01-LiTEK April 2009

A major source of risk facing Ethiopian and Kenyan pastoralists is the death of their livestock. Livestock deaths confront households not just due to the lost value of the animal itself, but also from the lost future potential of the animal to provide a flow of livestock products such as milk, blood, transport, or traction in the future. The well-known 'boom and bust' cycle in arid and semi-arid rangelands is based on widespread, sudden deaths of animals, followed by a long slow process of rebuilding the herd. Researchers from the PARIMA (Pastoral Risk Management) project asked herders over the course of a 'boom and bust' cycle from 2000 to 2002 to report on the reasons for each animal that died in their herd. This brief presents findings on their responses. The main finding is that deaths attributed to drought (58%) are the leading cause of animal death in the period. Animal disease (28%) and predators (6%) are also significant contributors to animal deaths. It is shown that drought deaths are concentrated in specific time periods. These findings indicate that the main interventions that will help reduce the risks associated with pastoral production should focus on reducing the impact of asset loss in droughts. It is also clear that projects focusing on improved livestock health could lead to a significant reduction in livestock losses.

Background

Over the course of the PARIMA (Pastoral Risk Management) project, the research team spent considerable effort on the analysis of household level responses to the risk of livestock loss and long-term herd dynamics (Lybbert et al. 2004; McPeak 2004, 2005, 2006a, and 2006b). The PARIMA project was developed alongside major advances in the study of rangeland ecosystems, such as the evidence collected in *Range Ecology at Disequilibrium* (1993) and other related publications. This 'new range ecology,' as it has been called, is based on the argument that 'boom and bust' cycles are inherent to extensive grazing systems that utilize rain-fed grasslands in arid and semi-arid areas. Researchers with the PARIMA team developed their fieldwork with a goal of understanding how people in these rangelands make decisions in the face of these kinds of risks and herd dynamics and seeking to understand the underlying causes of these dynamics.

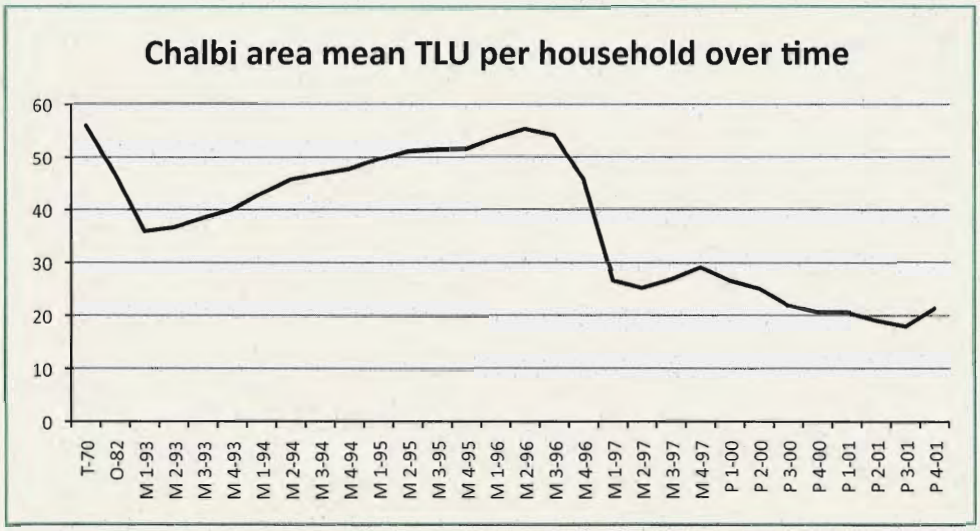
An example of a 'boom and bust' cycle is illustrated in Figure 1 using the PARIMA and other data sets gathered from Gabra herders in the Chalbi basin. On this figure, the y-axis records median herd size measured in Tropical Livestock Units (TLU) for the sampled herders, and the x-axis records time periods and source of the data. Here, studies by Torry (T) in 1970, O'Leary (O) in the early 1980s, McPeak in the 1990s (M), and PARIMA work from 2000-2002 referenced above (P) are put on a single graph. The first two surveys were single round surveys, and the latter two record quarterly data over multiple years, hence the -1, -2, -3, and -4 notation. Thus, the time intervals and sampling methodology differ. It is worth stressing that the x-axis is not equally spaced over time as the sampling frequency varies, and there are gaps of time between surveys. However, this does give some sense of long-term herd dynamics in the area.

Figure 1 illustrates that household herd size volatility over time may be pronounced. While the PARIMA team has made progress answering how the possibility of livestock loss influences pastoral decision making, the uncertainty of the causes of all of these livestock deaths became increasingly evident to members of the research team. Often, the answer was 'drought,' but this was in some ways unsatisfying since it often seemed tautological – it was a drought since many animals died rather than a drought as defined by some metrological or rangeland productivity measure. This brief describes how the write up of the PARIMA findings as conducted by the LiTEK team has moved towards understanding the underlying forces that lead to livestock mortality.

Preliminary Findings

While this brief sets the stage for an analysis of the underlying causes of livestock mortality, it is worth noting that considerable work remains concerning explanations of livestock deaths in the pastoral rangelands. The PARIMA data set is used to provide the context for understanding livestock mortality. Simply put, why do herders think their animals died, and what do the patterns in their responses mean?

Figure 1. Herd size over time for Gabra herders in the Chalbi area. Source: McPeak 2006a.



First, consider spatial and temporal variability in the mortality data. Temporal variability is represented by the reported value of deaths in TLU terms in both the rainy season and the following dry season (a six month period) divided by the TLU herd size reported at the start of the rainy season to get a seasonal mortality rate. This variable describes what percent of the herd died in the six months after the start of the rainy season. The spatial variability is represented by calculating the mean mortality rate for each of the eleven study sites. These figures are reported in Table 1, which covers four seasons (two years) of data.

The values in Table 1 illustrate there is significant spatial variation in the impact of a drought event that is being masked in Figure 1 by pooling data across all sites. Three main patterns are captured by this table. One pattern is that it was a year-long drought, with losses greater than 10% occurring in two consecutive six-month seasons. This would be the pattern in Ng'ambo, Logologo, Sugata Marmar, Kargi, Wachille, and Dirib Gumbo. A second pattern is a sharp drop in one six-month time period, after which the losses were not very large. Dillo, Dida Hara, Finchawa, and North Horr fit this pattern (though it is possible that there were losses in the season before the data gathering began in these sites which were not recorded). Finally, there is one site, Qorati, where it appears there were no significant losses. Whether the fact that this 'bust' exerted an impact over the course of two seasons is a general pattern or due to the nature of this particular event is something currently being researched by members of the LiTEK team and others who are looking at data on multiple bust events generated by the World Bank-funded Arid Lands Resource Management Project.

When gathering data on livestock mortality used to generate the figures presented in Table 1, PARIMA researchers asked the household head to assess the main cause of death for each of the animals they reported as dying. The number of deaths that were reported to be from a particular cause in each site in each time period can be categorized and counted. A death to any animal (camel, cattle, sheep or goat) is given equal weight in the summation in this presentation of the findings. If multiple causes of a single death were identified, each of the causes listed was given equal fractional shares of the one death recorded.

Over half of all mortality (58%) reported in the survey was attributed to drought or a drought related causes. The second leading cause of death is disease. Over one quarter (28%) of all animal deaths were attributed to diseases. Predators are also identified as a problem leading to 6% of deaths, and a variety of other causes account for the remaining 10% of deaths.

Table 1. Six month mortality rates by season and site.

Site	Mar 2000 - Sept 2000	Oct 2000 - Feb 2001	Mar 2001 - Sept 2001	Oct 2001 - Feb 2002
Ng'ambo, Kenya	45%	13%	5%	1%
Dillo, Ethiopia	34%	7%	0%	1%
Dida Hara, Ethiopia	31%	5%	3%	3%
Logologo, Kenya	28%	25%	3%	2%
Sugata Marmar, Kenya	25%	11%	7%	5%
Finchawa, Ethiopia	24%	2%	3%	0%
Kargi, Kenya	23%	17%	7%	4%
Wachille, Ethiopia	23%	12%	3%	5%
Dirib Gumbo, Kenya	20%	43%	6%	1%
North Horr, Kenya	14%	9%	0%	0%
Qorati, Ethiopia	3%	1%	0%	1%

Table 2. Total deaths by survey round and cause of death.

Survey round	Drought/lack of pasture/starvation/ emaciation	Disease	Predator	Accident	Killed to save mother	Old age	Rain/cold	Drank bad water	Other
June 2000	1446	417	32	6	11	7	0	0	12
September 2000	699	177	34	4	13	6	0	0	16
December 2000	440	218	37	6	0	10	75	57	26
March 2001	79	65	29	18	0	2	5	27	10
June 2001	0	63	19	1	0	0	0	1	6
September 2001	7	132	13	1	0	0	0	0	14
December 2001	0	114	58	5	0	2	0	0	5
March 2002	0	58	21	0	0	0	0	1	0
June 2002	0	51	16	1	0	0	0	0	10

The temporal pattern of these deaths is informative. Table 2 presents the causes of death by survey round and the number of deaths recorded in the survey. The deaths from drought, and the magnitude of total loss, are largest in the earlier rounds of the survey. Animal disease does lead to more deaths in the earlier rounds than the later rounds but is more of a constant problem besetting herders.

One final perspective on patterns in livestock loss can be found by considering spatial patterns in the magnitude of livestock deaths. Findings suggest that vulnerability to animal losses in drought is not necessarily associated with lower well-being. In fact, with the exception of Dida Hara in Ethiopia, the five sites with the highest number of animal deaths (Kargi, North Horr, Ng'ambo, and Logologo) are also in the top five for average income per site as reported in an earlier research brief (McPeak 2008). Also, the ordering of the number of deaths is not necessarily indicative of the mortality rates, which makes sense given that average herd size varies across the sites. While it is true that having more animals is associated with losing more animals and that well-being declines when animals die, there is no clear indication that being in a site where many of animals die in a drought means one is in a site with lower average well-being.

Practical Implications

Related briefs have stressed that livestock and livestock products are critical to generating income for residents of pastoral areas (McPeak 2009). Losses of livestock assets can have a direct adverse impact on people's well-being. Understanding what leads to livestock losses is therefore a critical challenge facing development efforts to improve the incomes and reduce the vulnerability of people living in pastoral areas. This brief illustrates that animal deaths are not distributed evenly across time. More animals died in each of the first three survey rounds in 2000 (June, 869 animals; September, 836; and December, 829) than the total deaths in the subsequent six rounds combined (total March 2001-June 2002, 675). Both drought and disease losses are concentrated in these three periods. This has led members of the LiTEK team and others to develop a program for index based livestock insurance in this area (Carter et al. 2008). This project is currently working to understand how remote sensing can be used to estimate when deaths are likely and to design commercial insurance products to help address this risk. Other projects active in this area, such as the Pastoralist Livelihood Initiative, have been exploring emergency feeding operations during droughts as an alternative to restocking after a drought (2007). Both insurance and emergency feeding operations could aid in minimizing the negative impact to household well-being due to droughts.

Furthermore, animal deaths are not distributed evenly across space. Three of the eleven sites, Kargi, Dida Hara, and North Horr account for 50% of recorded losses. This is perhaps not surprising, as these are three of the top four sites when ranked by TLU per capita in this survey; they have bigger herds so they have more to lose. However, it does illustrate that the magnitude of herd losses for a widely experienced drought, such as the one of early 2000, may have very different impacts by site. Any policy to help herders confront the risk of asset loss will have to recognize differences across sites in the impact of droughts.

Findings presented in this brief illustrate that livestock diseases and predators account for over one-third of deaths. Although drought is the major story revealed by this analysis, it is important not to overlook the fact that these two causes present different challenges and account for a significant amount of livestock deaths. Improved disease control in livestock and improved wildlife management could address two other significant sources of risk that lead to livestock losses.

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The Pastoral Risk Management project (PARIMA) was established in 1997 and conducts research, training, and outreach in an effort to improve welfare of pastoral and agro-pastoral peoples with a focus on northern Kenya and southern Ethiopia. The PARIMA project is led by Dr. D. Layne Coppock, Utah State University. Email: Lcoppock@cc.usu.edu. LiTEK is a continuation of the PARIMA project led by Dr. John McPeak, Syracuse University that focused on issues of livestock marketing and the compilation of PARIMA research findings. Email: jomcpeak@maxwell.syr.edu.

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In What Ways Are People in Pastoral Areas Integrated into the Cash Economy?

John McPeak, Syracuse University
Livestock Trade in Ethiopia and Kenya Project

Research Brief 09-02-LiTEK April 2009

In a prior research brief entitled "How Are They Surviving Out There? An Analysis of Total Income in the PARIMA Study Sites" (GL-CRSP Research Brief 08-02-LiTEK), the author described variation in total income across the eleven PARIMA study sites in southern Ethiopia and northern Kenya. Total income includes both cash income and the implicit cash value of goods that are produced and consumed by the household members without ever entering a market. Further analysis of the data presented in the earlier brief has revealed that access to cash income and access to livestock are key determinants in the generation of total income. In the current brief, focus is placed on how cash income is generated by different livelihood groups in the overall sample. Two important findings are that cash income from livestock and livestock product sales is found to be critical for all groups in the sample and that those with higher cash access are more reliant on wage, salary, business, and trade than those with lower cash access. Detailed findings on access to cash income illustrate that: income from livestock and livestock products is the most equally distributed of the sources considered; income from wage, salary, trade and business income is more unequally distributed; and income from sales of crafts, fuelwood, and water is the most unequally distributed. Two main policy implications are drawn. First, improving cash returns from improving livestock and livestock product markets impacts the largest share of cash income for the overall sample and impacts the type of income that is most widespread amongst the sample. Second, policies that increase access to wage, salary, trade, and business income offer the potential to increase income levels.

Background

In a prior research brief entitled "How Are They Surviving Out There? An Analysis of Total Income in the PARIMA Study Sites" (GL-CRSP Research Brief 08-02-LiTEK), the author described variation in total income across the eleven PARIMA (Pastoral Risk Management) study sites in southern Ethiopia and northern Kenya. Total income includes both cash income and the implicit cash value of goods that are produced and consumed by the household members without ever entering a market. Further analysis of the data presented in the earlier brief has revealed that access to cash income and access to livestock are key determinants in the generation of total income in pastoral areas.

Method. The analysis is conducted by returning to the PARIMA panel data set and recalling the distinction between cash income and total income drawn in the earlier brief. To summarize, total income combines cash income with the implicit value of home produced and consumed goods. Cash income is thus the subset of total income that is explicitly earned in the form of cash. In the overall sample, one third of total income is obtained in the form of cash; the other two thirds are not in the form of cash. As was stressed in the earlier brief, 41% of total income comes in the form of milk, underscoring the importance of livestock in generating income for people in this area.

This brief focuses on patterns in cash generation for the third of total income that comes in the form of cash. The analysis of household income generating strategies being conducted by the LiTEK team is based on dividing up the sample into four livelihood categories. Assignment of a household to one of the four categories is determined by access to two critical variables; cash income per person per day in the household, and livestock per capita in the household. Households are assigned to a category depending on whether the value of each variable is higher or lower than the median for all households in the sample. As this is panel data, the assignment is based on the value of the variable the first time the household was surveyed. Households are in one of four categories: the poorest of the poor (cash lower, livestock lower); those who may be more directly dependent on livestock products without significant market interaction (cash lower, livestock higher); those who may have found income generating activities outside of the livestock sector either by choice or necessity (cash higher, livestock lower); or those who combine higher than average access to the two assets (cash higher, livestock higher).

Major Findings

Table 1 reports the mean cash income for each category, and the coefficient of variation over time for each

Table 1. Mean cash income per person per day in US dollars (and coefficient of variation in income over time) by livelihood category[i].

	Cash Lower	Cash Higher
Livestock Lower	$0.05 (2.08)	$0.14 (1.31)
Livestock Higher	$0.04 (1.75)	$0.20 (1.14)

category. The coefficient of variation is calculated by taking mean household cash income over time and using it in the denominator with the standard deviation of household level cash income over time as the numerator. This generates a household specific coefficient of variation in cash income over time expressed as relative household variability about the household mean. This is then averaged across all households in a livelihood category to generate a representative coefficient of variation for each livelihood category. This illustrates the degree of variation over time in cash income at the household level for the average household in each category. All else equal, a higher coefficient of variation indicates higher vulnerability as it reflects a more variable cash income flow over time.

The values in this table provide two important findings. First, the cash lower - cash higher groups are clearly distinct groups in terms of the means. Cash income levels observed in the first round households were surveyed are therefore good predictors of cash income levels over multiple rounds of the survey; those more involved in the cash economy in the survey observation used to categorize livelihood groups tend to stay more involved in the cash economy in subsequent rounds. This suggests there is some support to the approach used to categorize households with regard to this variable. In contrast, access to livestock is not playing a significant role in determining average cash incomes over time when considering differences in a given column across the rows. Recalling that 41% of total income comes in the form of milk provides a reason that this variable can be used to divide households into livelihood categories. Somewhat more subtly, it is possible to see that household level variation about the mean for cash income is lower for those who are in the higher cash groups, and that it is lowest for those who can be considered the best off (livestock higher, cash higher) and highest for those who are arguably the worst off (livestock lower, cash lower). The difficulties faced by the more disadvantaged groups are not just represented in the lower mean income, but also in greater vulnerability to variation about this mean than better off groups.

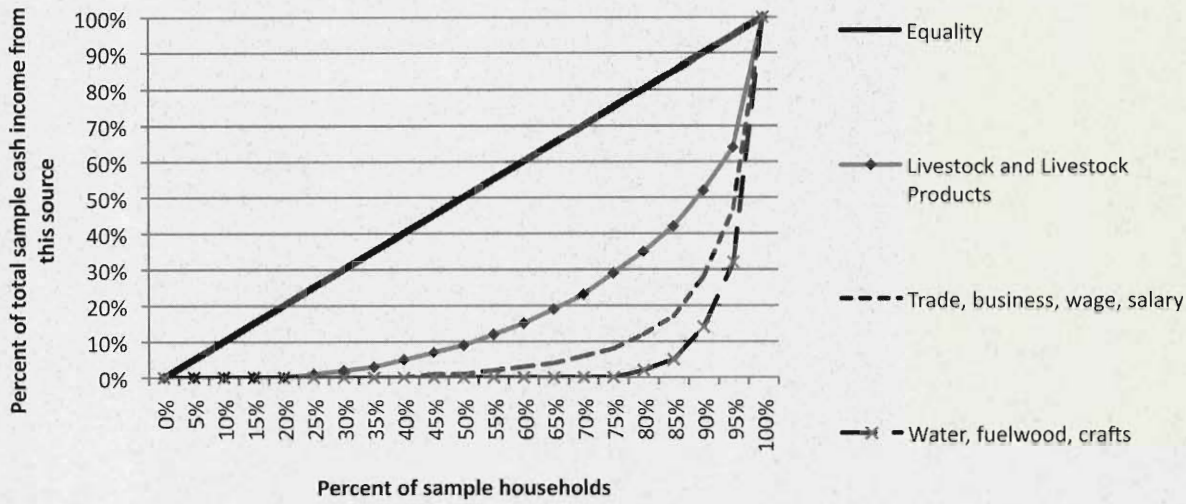
Table 1 provides evidence that access to cash income may differ by livelihood category. Do patterns of obtaining cash income also vary by livelihood category, and do these patterns help understand the difference in access to the cash economy across groups? To begin with, consider the magnitude of combined cash income from each of the following categories for the entire sample: livestock and livestock product sales (60% - 54% from livestock, 5% from milk, and 1% from hides and skins); wage and salary employment (17%); trade and business (12%); net cash transfers (8%[ii]); natural resource harvesting in the form of water sales, firewood or charcoal sales, and craft sales (3%). Wage and salary, trade and business, and net cash transfers will be combined for ease of exposition below. Returning to the livelihood categories allows investigation of how much cash income per person per day is coming into the average household in each livelihood category from these sources. Table 2 presents the cash income per person per day for sources of this income for each category.

The first finding of Table 2 is that livestock and livestock products provide the key link to the cash economy for most study households. This is immediately apparent for the values in Table 2 for all but the cash higher livestock lower group. For this group, the mean wage and salary contribution is higher than livestock and livestock products, but as will be illustrated, there is a great deal of inequality in the distribution of cash income from wage and salary. This inequality leads to the result that even though mean income from wage and salary is higher than livestock and livestock products for this group, median income from each of these sources is equal at $0.02. Another important finding is that the higher cash groups have significantly more non-livestock cash income coming from wage and salary and from trade and business. The two lower cash groups are clearly different from the two higher cash groups in the wage and salary and trade and business columns. Net gifts are modest and seem, if anything, to go to those with more livestock. Finally, no group is making significant cash income from sources such as

*Table 2. Cash income per person per day by livelihood category and source of income. * The numbers in Table 1 and Table 2 are consistent, but do not tally due to rounding.*

	Livestock and Livestock Products	Wage and Salary	Trade and Business	Water, Firelwood, Crafts	Net gift
Cash lower, livestock lower	$0.03	$0.01	$0.01	$0.001	$0.00
Cash lower, livestock higher	$0.03	$0.01	$0.01	$0.000	$0.01
Cash higher, livestock lower	$0.04	$0.07	$0.03	$0.003	$0.00
Cash higher, livestock higher	$0.08	$0.07	$0.05	$0.003	$0.01

Figure 1. Lorenz curves for distribution of cash income sources across households.



water selling, firewood selling, or craft sales. These activities, which might be seen as potential labor intensive/lower skilled entry points to the cash economy, offer little in the way of significant cash returns overall for any group.

As just discussed, there are reasons that averages as reflected in means may not be fully informative about the impact of different cash income sources if the distribution of this source of income is not widespread across households. This can be illustrated by considering Lorenz curves. A Lorenz curve describes what percent of a total asset (on the y axis) is controlled by what percent of the population (on the x axis), if the population is ordered from left to right by least control to most control. Here, the asset is cash income from a particular source. The closer a Lorenz curve is to a 45-degree line, the more equal the distribution of the asset (on a 45-degree line, 10% of the population controls 10% of the asset; 50% controls 50%, and so on). Figure 1 illustrates Lornez curves for the distribution of livestock and livestock product cash income; wage and salary, trade and business cash income; and income from water, firewood and craft sales across the households of the sample. It is visually apparent that livestock and livestock product cash income is much more equally spread across the households in the sample, while income from the other sources is heavily skewed towards a few households. These curves imply that the upper quartile of each cash source controls: 71% of the income from livestock and livestock products; 92% for the wage and related sources; and 100% for the water and related sources. From another perspective this figure illustrates that: 21% of households earn zero cash income from livestock and livestock products; 45% earn zero from wage and related sources, and 77% earn zero from water and related sources.

Practical Implications

In the preceding brief, the importance of milk produced in generating total income in the PARIMA sample was stressed, suggesting improving milk productivity had the potential to impact many households positively in the study area. Here, the findings are related in that cash income from livestock and livestock product sales is found to be most important, both in terms of the average contribution to income and in terms of how many people are gaining income from this category. Simply put, livestock and livestock products are the core element to how people in pastoral areas generate both total income and cash income. The most effective and direct efforts to increase incomes in this area should therefore target increasing returns to livestock and livestock products. While this may not be surprising, it is still worth stressing that livestock are the key to this economy and to people's well-being within it.

It is also notable that a key distinguishing feature between those with higher cash incomes compared to lower cash incomes is access to the economy through wages, salary, trade, and business. An emphasis on livestock and livestock products is important, but it should not lead development efforts to focus solely on livestock production. Access to the cash economy through formal sector employment or trade and business can be fostered at one level by improving education, at another by developing management skills, and also by improving access to credit that will allow increased investment that will lead to more involvement in the cash economy in these areas. When addressed together, these kinds of efforts offer the promise of improving well-being and reducing poverty and vulnerability of pastoralists in East Africa.

Further Reading

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Endnotes

[i]*Denoting the lower cash lower livestock group as 1, the lower cash higher livestock group as 2, the higher cash lower livestock group as 3, and the higher cash higher livestock group as 4, the difference in means is not statistically significant between groups 1 and 2 and between groups 3 and 4. All other comparisons are significant at a 5% or better level. For the coefficient of variation, the differences are statistically different at the 1% level for groups 1 and 4 and 3 and 4, and at the 5% level for groups 2 and 3. Significance is determined by a t-test assuming unequal variances.*

[ii]*In retrospect, researchers were not as precise in wording the question about net gifts as they would like to have been. It is not possible to draw a clear distinction between cash gifts from people resident in the area and outside the area due to the wording of the question. Researchers believe a large part of this can be thought of as urban to rural remittances but do not have the data to distinguish gifts originating out of the community from those originating within the community.*

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The Pastoral Risk Management project (PARIMA) was established in 1997 and conducts research, training, and outreach in an effort to improve welfare of pastoral and agro-pastoral peoples with a focus on northern Kenya and southern Ethiopia. The PARIMA project is led by Dr. D. Layne Coppock, Utah State University. Email: Lcoppock@cc.usu.edu. LiTEK is a continuation of the PARIMA project led by Dr. John McPeak, Syracuse University, that focuses on issues of livestock marketing and the compilation of PARIMA research findings. Email: jomcpeak@maxwell.syr.edu.

The Global Livestock CRSP is comprised of multidisciplinary, collaborative projects focused on human nutrition, economic growth, environment and policy related to animal agriculture and linked by a global theme of risk in a changing environment. The program is active in East and West Africa, Central Asia and Latin America.

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GLOBAL LIVESTOCK CRSP

Risk Ranking in Northern Mali

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Mali Livestock and Pastoralist Initiative

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Livestock producers in sub-Saharan Africa face a great deal of risk, and have long established coping mechanisms to manage these risks. A goal of GL-CRSP Mali Livestock and Pastoralist Initiative (MLPI) risk management research in 2008 was to identify the kinds of risks residents of Tenenkou cercle, *an administrative subdivision of the Mopti region in Mali, identify as most prominent. The Inland Niger Delta, found within the Mopti region, represents an important dry season pasture resource for a significant fraction of Mali's livestock population. We also sought to understand how assessments of risk could vary across sites, seasons, livelihood groups, and gender. In this preliminary approach to the issue, we conducted open-ended interviews with groups of people in an area known in great depth by one member of the research team (Turner). This initial approach was designed to address a second goal of MLPI preliminary research, which was to understand how to pose questions in a larger risk management survey fielded in 2009. Findings from the preliminary approach indicate that there are some similarities and contrasts between the risks identified in the GL-CRSP PARIMA project East African study and the current Mali study, while the main differences between the two areas would appear to be related to the higher reliance on markets in East Africa and the greater reliance on cropping within the Malian study population. The impression left by these findings is that risk perceptions in Tenenkou may in fact vary more within a geographically defined community than was the case among the PARIMA study population in Kenya and Ethiopia. While there is heterogeneity within communities in the East African sample, it would appear that the social complexities are much more pronounced in the Inland Delta of Mali. These preliminary findings led us to initiate a broader study of risk management in the MLPI study area designed to be consistent with work done by the Consultative Group for International Agricultural Research's (CGIAR) Systemwide Livestock Program, which ran similar risk surveys in Niger and Kenya. Results based on this comparative work are expected to be generated in 2010.*

Background

Livestock producers in sub-Saharan Africa face a great deal of risk, and have long established coping mechanisms to manage these risks. A goal of the Mali Livestock and Pastoralist Initiative (MLPI) risk management research in 2008 was to identify the kinds of risks residents of Tenenkou *cercle*, an administrative subdivision of the Mopti region in Mali, identify as most prominent. The Inland Niger Delta, found within the Mopti region, represents an important dry season pasture resource for a significant fraction of Mali's livestock population. We also sought to understand how assessments of risk could vary across sites, seasons, livelihood groups, and gender.

A core issue confronted when conducting a study of risk perceptions is the meaning of 'risk' in a particular context. How do people understand risk and vulnerability, and in a related fashion, what words do they use to describe these concepts? We found three core challenges in approaching the question of risk perceptions in the Tenenkou area.

First, the idea of an individual's risk exposure was hard to linguistically isolate from the idea of an individual's risky behavior. The closest translation of exogenous risk is the "work of God" *(golle Allah)*. Phrased in this way, it proved somewhat difficult to talk about how people's actions expose them to differential exogenous risk. The literal translation of risk is associated with an individual's endogenous behavior, in the sense that bad outcomes are the result of bad choices, as compared to covariate exposure to exogenous shocks, in the sense that bad outcomes are a reflection of the bad luck that comes to us all and sometimes comes to us all at the same time. A second linguistic issue was that risk is tied up in the idea of 'problems'. Some of the items people would identify as risks are not shocks in and of themselves as viewed by a stochastic concept of risk (a good example was people complaining about the discomfort brought on by the cold of the cold-dry season), but are related to what can be thought of as a shock that can result from the predictable problem of a cold period (there was a sense that the cold was tied to the likelihood of falling ill in this season, where illness is in a probabilistic sense a shock). A third issue was that any time you have people from outside showing up in a Land Cruiser who have come to ask about 'risks', you are bound to get people thinking instead about a related but distinct concept of 'needs'. Responses at times were clearly motivated by a

desire for external funding to solve a particular problem (for example, people would cite as a risk a lack of farming equipment, a lack of seeds, or the need for an improved road to the women's garden because the current one is underwater following the rains).

Methods

In a preliminary approach to understanding risk in Tenenkou in light of these issues, we conducted open-ended interviews with groups of people in an area known in great depth by one member of the research team (Turner). For the interviews, we assembled groups of people from different backgrounds in different communities. Different groups were assembled based on their livelihood priority (livestock husbandry, farming, blacksmiths, and fishing), production landscape (on and off of the floodplain) and gender. Despite the fact that there are clear distinctions in livelihood identities, all groups depend on farming (rice and millet farming, on and off of the floodplain, respectively). These were not particularly formal meetings, and there were often people coming and going over the course of the discussion. After explaining the purpose of the visit, asking for the assent of the group to conduct the questions, and thanking them for taking the time to talk with us, we went forward with a set of questions about risk perceptions in the area.

We divided the year up into the four seasons represented in the local Fulfulde language: a rainy season = *ndungu*, a short hot dry season = *yaounde*, a long cold dry season = *dabbunde*, and a long hot dry season = *ceedu*. We combined *ndungu* and *yaounde* into a single season, as *yaounde* is only a month long and seemed to face many of the risks described for *ndungu*.

Following the seasonal division, we asked the group to list all the risks they could think of for the given season. After writing down all group responses, we asked them to rank the listed responses beginning with the biggest problem, and continuing on to the smallest problem. Our list was restricted to the top five responses if there were over five given for a season. This exercise was continued until completing the risk rankings for all three major seasons *(ndungu, dabbunde, ceedu)*. We then asked participants to think of the top response for each season in an annual context. How would they order the top problem for each season in terms of the top problem faced over the course of an entire year?

Findings

Given the context described above, these results are of course to be treated with caution. The groups were ad hoc, the size of the group went from one person to over 20, and in the larger groups the total number is probably misleading, as the data collected often reflect only the input of a few members, and the understanding of the question differed across and within groups. There are clearly some significant problems to our methodology, mainly arising from the short-term and exploratory nature of the study; it was in essence a week-long preliminary field investigation.

Table 1. Top ten overall risk ranking scores.

Risk	Average Score
Lack of food	0.34
Human sickness	0.26
Birds attack crops	0.20
Animal sickness	0.18
Lack of water	0.18
Weather issues	0.17
Farmer-herder conflict	0.13
Rains fail	0.08
Flooding problems	0.07
Lack of pasture	0.07

The risk rankings are put on a [0,1] scale by normalizing by the number of items ranked, as was done in the GL-CRSP Improving Pastoral Risk Management on East African Rangelands (PARIMA) project studies reported in Smith et al. (2001) and Doss et al. (2008). One always refers to the top ranked item, while zero refers to an item that was not ranked or noted. The number assigned to something ranked (other than the top item or not at all) depends on the total number of items ranked. For example, if there are three items ranked: 1 = score for top ranked item; 0.67 = score for item ranked number two; 0.33 = score for item ranked number three; 0= score for all other items.

First, we can consider the overall average risk ranking results. In Table 1, we have pooled all the results by season, after grouping related responses into categories. The averages are calculated for all groups over all seasons.

One important finding is that there are some similarities and contrasts between the risks identified in the PARIMA East African study and the current Mali study. Doss et al. (2008) report the top five risks as: food shortages; human sickness; lack of pasture; high prices for things you buy; and animal sickness. In this study, the top five are: lack of food; human sickness; birds attacking crops; animal sickness; and a lack of water. The main differences between the two areas would appear to be the higher reliance on markets in East Africa and the greater reliance on cropping within the Malian study population. That would match the fact that the Inland Delta is a productive flood plain where cropping is of high importance, compared to the

Table 2. Top five risk ranking by season.

	Rainy Season *(Ndungu)*	Cold Dry Season *(Dabbunde)*	Hot Dry Season *(Ceedu)*
1	Human sickness	Weather issues	Lack of food
2	Birds attack crops	Farmer-herder conflict	Lack of water
3	Lack of food	Human sickness	Lack of pasture
4	Animal sickness	Flooding problems	Animal sickness
5	Rains fail	Low prices for things you sell	Brush fires

East African rangelands of the Doss et al. study, where cropping is a minor activity.

There is some pronounced seasonality to these rankings revealed by further analysis. The top five risk ranks by season are reported above in Table 2. First, most of the risk seems associated with the hot dry season *(ceedu)* and the rainy season *(ndungu)*. The cold dry season of *dabbunde* that follows the rains is generally seen as somewhat benign though chilly.

We also can report that there is evidence for inter-group differences in risk perception. One aspect of this is potential gender differences. Focusing just on the risk ranks for the groups of women, we have an indication that women may rank risks differently than men. In addition, women in the open-ended question suggested that this would be the case. It remains to be seen whether it is true using more rigorous methods, but there are indications that risk perceptions may be influenced by gender. Note that we also found that gender differences appeared to matter in the first risk study in East Africa (Smith et al. 2001) that were not eventually supported by the individual level surveys (Doss et al. 2008). This was probably because the first study interviewed groups in different communities, and interviewing a women's group in one community and a men's group in another community ran the risk of interpreting as a gender difference what could be a community level difference. In contrast to Table 1, however, Table 3 displays evidence that women's groups have different risk ranking patterns, with health being more pronounced, and birds attacking crops being much less pronounced.

Table 3. Top ten risk ranking for groups of women.

Risk	Average Risk Rank
Human sickness	0.43
Lack of water	0.34
Lack of food	0.33
Weather issues	0.20
Low prices for things you sell	0.15
Animal sickness	0.11
High prices for things you buy	0.11
Flooding problems	0.11
Housing issues	0.09
Birds attack crops	0.09

There were also clear differences in risk perceptions based on livelihood strategies combined with a person's background. The fishing communities had very clear concerns about the riskiness of fishing, though within the fishing community, some groups had stronger rights to fishing areas than another, which influences their risk perceptions. Rice cultivators had a set of rice-specific concerns, which were similar, though not identical, to the concerns of millet farmers. However, the millet farmers (who live beyond the high water mark of the Niger Delta floodplain) had a whole other set of concerns based on supplying fuelwood to the towns during the dry season (an important cash-earning activity for this group during the dry season).

Practical Implications

The impression left by these preliminary results, is that the risk perceptions may in fact vary more within a geographically defined community than was the case in the PARIMA project's East African study population. While there is heterogeneity within communities in the East African sample, it would appear that the social complexities are much more pronounced in the Inland Delta of Mali. While it may turn out that within social groups we find more homogeneity of risk perceptions, as an operating hypothesis we speculate that there is likely to be more variation within a geographically defined community in the Malian context than we found in the Ethiopian and Kenyan context, where there was relatively less diversity in livelihood strategies. While the Inland Delta is known for its social heterogeneity, other parts of Sudano-Sahelian West Africa may still show greater heterogeneity than found in the East African case since it is much more common for "communities" to be composed of social groups (casts, ethnicities, lineages) with a range of livelihood identities.

The findings of this study led us to design a broader study of risk management in the Malian study area. This was designed to be consistent with work done by the

Consultative Group on International Agricultural Research's (CGIAR) Systemwide Livestock Program. The CGIAR project ran similar surveys in Niger and Kenya. We adapted their questionnaires to be applicable to the northern Mali study area in order to maintain comparability with cross country differences, while ensuring the questions made sense to Malian respondents. Results based on this comparative work are expected to be generated in 2010.

Further Reading

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Building on the successes of the GL-CRSP Livestock Early Warning System/Livestock Information Network and Knowledge System (LEWS/LINKS), Improving Pastoral Risk Management on East African Rangelands (PARIMA), and Forage Monitoring Technology to Improve Pastoral Risk Management by Herders in the Gobi Region of Mongolia (GOBI Forage) projects, the Mali Livestock and Pastoralist Initiative (MLPI) was initiated in January 2008, to develop a livestock market information system, and to examine strategies for reducing risk and improving livestock marketing options for the enhancement of pastoral livelihoods in Mali. The project is a collaboration between the Global Livestock CRSP and the USAID Mission to Mali, with Texas A&M University and Syracuse University as the US implementing partners. The project is led by Dr. Jay Angerer, Texas A&M University. Email: jangerer@cnrit.tamu.edu. The Co-Principal Investigator is John McPeak. Email: jomcpeak@maxwell.syr.edu.

The Global Livestock CRSP is comprised of multidisciplinary, collaborative projects focused on human nutrition, economic growth, environment and policy related to animal agriculture and linked by a global theme of risk in a changing environment. The program is active in East and West Africa, and Central Asia.

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GLOBAL LIVESTOCK CRSP

Role of Farmer Organizations in the Strategy for Improving the Quality of Life for Livestock Producers in Northern Mali

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This study investigates the potential for farmer organizations to be of assistance to livestock producers by looking at the broader issue of farmer organizations in northern Mali as a way of gauging the potential for such groups to be of assistance in the livestock sector. The study was conducted in the regions of Mopti, Tombouctou and Gao, which are very productive livestock raising areas. A participatory approach was adopted, targeting two villages within the administrative area of each region, through interviews with focus groups, individual interviews with members of organizations, and interviews with key informants. The study yielded several results of interest concerning: policy and development actors and their relation to farmer organizations; functional relations between organizations and agricultural policies; relations of power within farmer organizations; the different forms of organizations; and strengths and weaknesses of different forms of organizations. Findings show that formal and informal farmer associations are numerous in northern Mali and intervene in various fields. However, in some sites, farmer organizations exist in name only, and are used exclusively by leaders to receive support for themselves; a finding with drastic implications for agricultural development projects relying on these groups as there is a no guarantee that the benefits of such projects will actually reach targeted beneficiaries. Formal organizations attract more farmers in view of the many benefits they provide to members through the support of the State or of technical and financial partners. In spite of this, overall it appears that farmer organizations have very little influence on agricultural policies at any level, and that there is very little role currently played by groups allowing collective action in the livestock sector. When these organizations are capable of cohesion, however, we were able to see how they achieve economies of scale in marketing activities and influence decisions in a way favorable to the interests of members, indicating that farmer organizations as currently structured in northern Mali are largely a case of unrealized potential.

Background

Farmer organizations are among the most important and legitimate actors responsible for promoting agricultural development in developing countries. These organizations are formed voluntarily by professional groups formally or informally (association of producers, cooperatives, union of cooperatives, and associations) operating in different areas. They represent a strategy of collective action to influence government decisions or other institutions on behalf of communities composed of members who are generally poor and relatively powerless as individuals. They can also offer cost savings in terms of input markets or higher returns in output markets though collective action. As such, there is a promise of benefits to working with farmer associations in the livestock sector.

This study attempts to analyze the influence of farmer organizations on political and administrative authorities in terms of influencing policy, and also their role in fostering access to basic services (farm inputs, market information, and higher return markets). For this purpose, roles and responsibilities of agencies in the formulation and implementation of development policies more favorable to the most disadvantaged players were reviewed.

Methods

The study adopted a participatory approach through interviews with focus groups, individual interviews with members of organizations, and interviews with key informants. It consisted of an inventory of organizations and support structures in the area, describing the collective activities of organizations and the governance thereof.

The study focused on the regions of Mopti, Tombouctou and Gao. In each region, *cercles*, a subdivision of a region, and corresponding technical support services were identified. Two villages were selected in each *cercle* to conduct interviews and surveys. The interviews were held with groups (some all male, some all female, and some mixed) whose principal activity is agricultural. In addition to group interviews, three farmers were interviewed individually (a leader of the organization, and two members of the organization – one male and one female if mixed composition). Finally, a key informant was interviewed in each *cercle* to identify the situation of organizations of the area as a whole from his or her perspective. The information collected was analyzed to understand how different organizations perform based on structures of support, goals, strengths, weaknesses, and gender.

Findings

There are several types of farmer organizations, which differ in their functions and types. In northern Mali, the organizations identified are broadly represented in Table 1.

In Mali, the agricultural policies that have succeeded since independence have been targeted to certain products (cotton, rice, peanuts, and to a lesser extent livestock), certain areas (over 800 millimeters of rain per year), and particular professional groups (retailers and consumers). Analysis of these policies shows the increasing role played by farmer organizations since the advent of democracy in the country. These include unions of rice producers in the Office du Niger, the union of cotton producers, and with regard to the topic of this study, the National Federation of the Livestock-Meat Sector in Mali (FEBVIM), though this is more targeted at the merchants and butchers than the livestock producers. The importance of these organizations are related to the relative importance of commodities for the country in terms of production, the level of prices for the commodity in the domestic market, the level of prices in export markets, or some combination of these elements.

Groups of farmers in northern Mali are often marginalized in decisions because of their remoteness from the main areas of production and consumption, and the difficulties this generates in terms of their access to information and input to decision-making. In addition, the study revealed that organizations commonly encountered in this area are generally not effective at advocacy with partners and government for consideration of their grievances. Organizations in this area are almost all in the least structured level of collective action (association), rarely are they at a cooperative or higher level of organization.

Table 1. Types of farmer organizations identified in northern Mali.

Status	Level	Type
Formal	National	Fédération
	Régional	None identified
	Local	Coopératives
		Associations
Informal	Local	Associations

Currently, efforts are being made by the technical and financial partners, donors, political parties, non-governmental organizations (NGOs), and often religious organizations for the promotion of farmer organizations. The activities that correspond to these efforts are focused on a set of activities such as the establishment of input shops, leadership training, and access to credit. In contrast to the relatively common set of activities, our work indicated that the different promoters of farmer organizations often follow different strategies using different approaches in addressing these activities. This leads to a multiplicity of organizations in a given site using different approaches to the same activity; the ensuing confusion at least partially

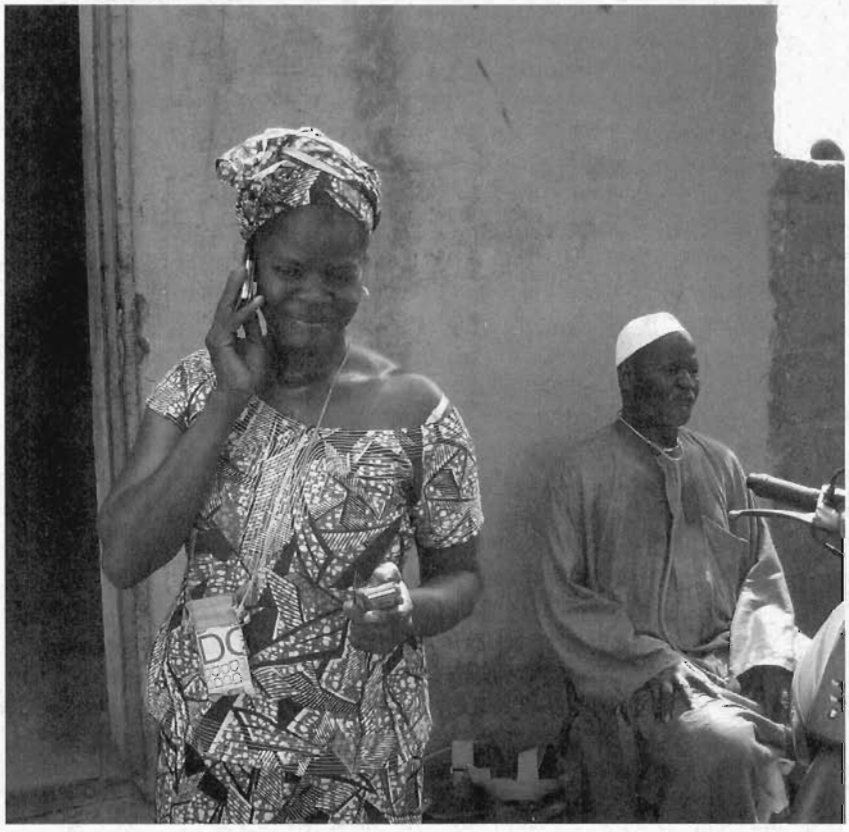

Figure 1. The first female market monitor recruited and trained for the MLPI Livestock Market Information System (LMIS), accesses market and price information from the LMIS via her cell phone. MLPI is working to empower women through increased participation in livestock marketing activities and collective action groups, though traditional farmer organization structures often exclude women and discourage their participation. Photo by Jay Angerer.

Box 1. Reasons identified for the resistance to change of power relations in study communities.

The physical dispersion of the rural population makes it difficult to identify common grievances and possible solutions.
Existing social relations of dependency, or conflict between members or sub-groups in these communities work against cooperation.
Constraints of information flow in rural areas increase the difficulty of identifying common problems or potential solutions.

explains the modest performance of each individual organization.

In agricultural policy design and implementation, the ideal of farmer organizations is that policies are defined democratically after extensive consultations among stakeholders, to analyze constraints and identify options for solutions that are suitable for the local context that will be supported by funding partners. The size of the country, the limited public finances, and the decentralization process do not allow the state to meet the needs of all organizations, thus creating the space for other kinds of assistance to be sought out. In this context, farmer organizations can be active in ensuring access to agricultural inputs, training, and information to members of organizations. The reality we encountered in our survey work is that large professional organizations (unions, federations of cooperatives, or associations), which are represented in Bamako, are more likely to be capable of exerting an influence on decision-making by government and program design by donors. Despite the undeniable contribution of these organizations in improving rural incomes, it is clear that most of them have been created to serve the interest of the group leaders rather than focusing on meeting the needs of all members. Thus, some organizations are limited by membership, areas and scope of their activities, and do not really represent the overall interest of rural producers in a given area. To remedy this situation, farmer organizations should be open and accessible to the poor, democratic, effective, and relevant in the choice of targets.

We encountered a variety of organizational types in the villages. There are formal and informal groups, groups of men, women, or mixed groups. As noted above we found that in general, local groups were led by a small number of beneficiaries who derive the greatest benefit from the group. Within these organizations we found consistent evidence that the stronger members derive benefits that are not obtained by the weaker members. Indeed, although they are almost always the majority, we found members who were not in the core leadership generally unable to identify their constraints, to express their needs, or to make choices or propose solutions to better their outcomes. This largely explains the failure of some agricultural development projects initiated by donors that rely on farmer organizations. Power relations that exist in communities resist change for various reasons, and are identified in Box 1.

We also found that in many cases, farmer organizations are influenced by the technical services, NGOs, and technical and financial partners in the identification and implementation of development projects. Note that this is in contrast to the idea that members express their collective interest through the group and are assisted in asserting their will with outside assistance. Our work in the field indicates this pattern recurs due to a lack of organizational resources in the local communities, the low level of training of members, and frequent divergence of interests within the group, so that subgroups take advantage of outside resources and support to press for their interests within the group. In some sites, we found that farmer organizations exist in that area in name only, and are used exclusively by leaders to receive support for themselves.

The organizations include within them many members who could potentially take collective action and impact the sale or purchase of bulk goods and services. When organizations are capable of cohesion, we were able to see how they achieve economies of scale in marketing activities and influence decisions in a way favorable to the interests of members. This indicates that farmer organizations as currently structured in northern Mali, are largely a case of unrealized potential. We will be working in the area to see how the benefits of collective action can be more accessible to livestock producers in northern Mali.

The activities undertaken by farmer organizations in the livestock sector identified in the field mostly centered on the supply of livestock feed, as marketing decisions are taken exclusively by individuals. However, there is potential for group action in the livestock sector, perhaps building on the work of groups obtaining feed for animals. Any associations targeted for support in the livestock sector must build on the positive lessons, and learn from the negative outcomes encountered by other types of producer organizations in the area.

Practical Implications

Producer organizations, in particular farmer organizations, are numerous in northern Mali. However, the level of training of their leaders is generally very low. In addition, we found numerous examples where leaders were elected not because of their effectiveness but because of the positions they occupy in society. There is evidence

that weaker members of communities who are not in core leadership positions are generally unable to actively engage in decision-making, due to a lack of capacity along with the traditional structure of the farmer organization. As the majority of these organizations are composed of and run by males, there is also very little room for female participation. This organizational structure has drastic implications for agricultural development projects relying on these groups; there is a no guarantee that the benefits of such projects will actually reach targeted beneficiaries. While the formal organizations attract more farmers and were seen to provide greater benefits to the members through access to outside funds and expertise, farmers' organizations in northern Mali, in their present state, have very little influence on agricultural policies at any level, and there is very limited use of farmer organizations in the livestock sector.

In conclusion, there is considerable room for improvement of these organizations through capacity building and collective action, especially among livestock producers. We hope to build on these findings and advise local farmer organizations on how best to obtain the benefits of collective action in the livestock sector, while avoiding problems encountered by farmer organizations in other sectors.

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Building on the successes of the GL-CRSP Livestock Early Warning System/Livestock Information Network and Knowledge System (LEWS/LINKS), Improving Pastoral Risk Management on East African Rangelands (PARIMA), and Forage Monitoring Technology to Improve Pastoral Risk Management by Herders in the Gobi Region of Mongolia (GOBI Forage) projects, the Mali Livestock and Pastoralist Initiative (MLPI) was initiated in January 2008, to develop a livestock market information system, and to examine strategies for reducing risk and improving livestock marketing options for the enhancement of pastoral livelihoods in Mali. The project is a collaboration between the Global Livestock CRSP and the USAID Mission to Mali with Texas A&M University, and Syracuse University as the US implementing partners. The project is led by Dr. Jay Angerer, Texas A&M University. Email: jangerer@cnrit.tamu.edu. The MLPI Co-Principal Investigator is John McPeak. Email: jomcpeak@maxwell.syr.edu.

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GLOBAL LIVESTOCK CRSP

Implementation of a Livestock Market Information System for Mali: Price and Volume Results for Five Major Markets

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A livestock market information system was developed for Mali and was patterned after the system developed by the GL-CRSP in East Africa under the Livestock Information Network and Knowledge System (LINKS) project. In September 2008, data collection began at three markets in northern Mali (Gossi, Konna, and Kidal) and two terminal markets (Kati and Niamana) near Bamako. For each market, monitors were trained to use cell-phone short messaging service (SMS) to send data on volume (i.e., number of animals presented at the market) and price based on animal kind, breed, sex, age, and grade (fat, medium, or thin). Initial results indicate that, as would be expected, the terminal markets of Kati and Niamana had larger volumes of cattle and sheep presented than those in northern Mali. For sheep, the Kati market had the greatest volume (93,170) during the period of September 2008 to December 2009, which was 2-3 times greater than the northern markets. The Niamana market had the greatest volume of cattle (127,545), which was 7-10 times greater than the northern markets. Price differentials existed by grade of animal with fatter animals generally commanding greater prices at all markets than thin or medium grade animals. For both sheep and cattle, the Kati market exhibited the greatest price differential with fat animals exhibiting, on average, a 200 to 300% higher price than thin animals. Large price differentials between fat and thin animals were also evident in the weeks leading up to national holidays such as Tabaski. *Initial results of the LMIS provide information to develop extension messages for fattening of animals to increase profits and for examining risk associated with selling animals at the terminal markets where market prices are generally higher.*

Background

The USAID Mission to Mali has identified an overall goal of improving productivity and income of the livestock producers in the northern regions of Mali by enabling them access to new technologies and by building capacity for all actors involved in development of an extensive livestock system. To assist in meeting this overall goal, Texas AgriLife Research/Texas A&M University under the Global Livestock Collaborative Research and Support Program (GL-CRSP), in partnership with Observatoire du Marche Agricole (OMA) and the Direction Nationale des Productions et des Industries Animales (DNPIA) are working to establishment a state-of-the-art livestock market information system (LMIS) for Mali. The LMIS for Mali is patterned after the system developed in East Africa (Ethiopia, Kenya, and Tanzania) as part of the USAID/GL-CRSP's Livestock Information Network and Knowledge System (LINKS) project. Partnerships with OMA and DNPIA were sought for developing the system because of their current integration in market data collection. OMA brings experience in developing and deploying a market information system for food commodities and in market information data collection. DNPIA has a network of market monitors across Mali that collect price and volume information from the livestock markets; however, data transmittal times are slow, thus reducing the effectiveness and timeliness of the information.

The overall goal of the LMIS deployment is to develop a useful and timely system to report, and make available to the public, the price and volume information from livestock markets on a near real-time basis. Through this, we hope to improve and expand the analytical, reporting, and geographical relevance of the data and make livestock price and volume data more transparent for all stakeholders in Mali.

The LMIS is designed to allow data collected at livestock markets to be entered into the system via short messaging service (SMS) messages from cellular telephones. A coding system is used for the SMS messages that allows the market data collectors to send livestock price and volume information by livestock kind, breed, age, sex, and grade. The data is sent to a central server in Bamako, where it is stored in a local database on the system. Pastoralists, livestock traders, and other interested stakeholders can then request the price and volume information for specific markets using SMS and an abbreviated set of codes. The data are also made available through the Internet via a market information portal (http://www.malibetail.net). This portal allows users to view trends in market data over time by kind, breed, age, sex, and grade. It also has modules for developing reports and for conducting market chain analysis.

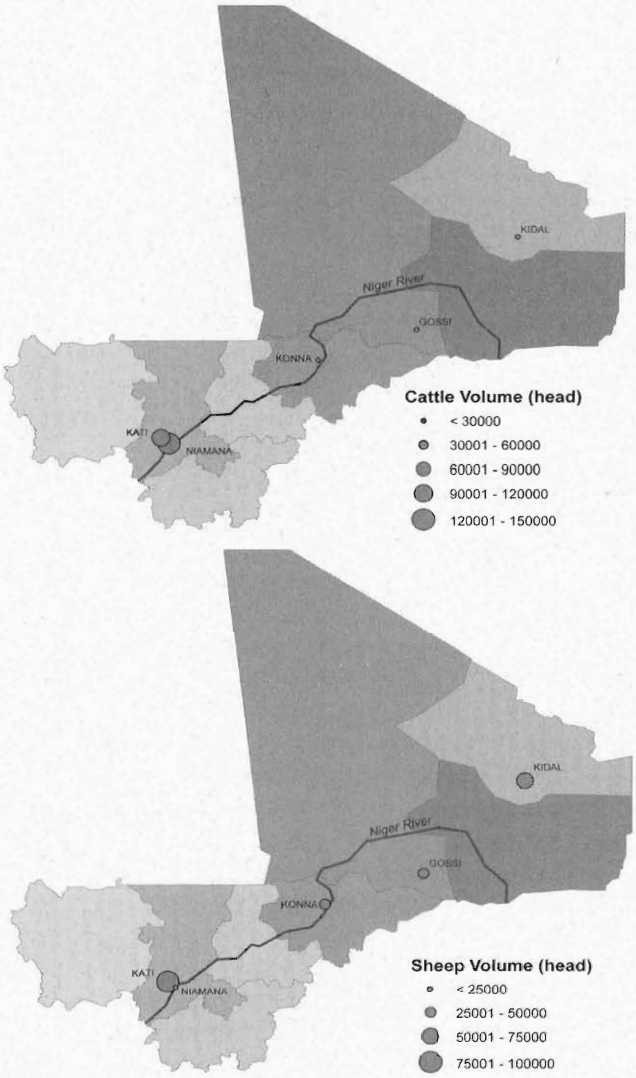

Figure 1. Location of the five livestock markets examined for price and volume difference in Mali. Cattle and sheep volume at the markets are represented on a graduated scale with smaller circles representing lower total volume of animals than larger circles during the period from September 1, 2008 to December 1, 2009.

In August 2008, training was conducted for market monitors at five major markets in Mali (Figure 1). Three markets (Konna, Gossi, and Kidal) from northern Mali were represented as well as two markets near Bamako (Niamana and Kati) . Market monitors were introduced to the LMIS coding protocol and trained in the use of SMS messaging for entry of data into the LMIS. Market monitors were also trained in livestock grading procedures in order to capture price differentials that may exist between fat, moderate, and thin animals for the different kinds, breeds, age, and sex of animals presented for sale at the market. Beginning in September 2008, data collection began at each of the five markets. The objective of this brief is to present the initial results on price and volume trends at these five market during the period from September 1, 2008 to December 1, 2009. Price differentials between thin, medium, and fat grades for mature sheep and cattle are also examined.

Preliminary Findings

During the period from September 1, 2008 to December 1, 2009, reported cattle volume was greatest at the terminal markets of Niamana and Kati near the national capital of Bamako (Figure 1) when compared to the markets in northern Mali. The Niamana market is located approximately 15 kilometers (km) southeast of Bamako and the Kati Market is located approximately 20 km to the northwest. Each of these markets provides meat animals to Bamako, but also serves as a market where traders purchase animals for export to Senegal, Côte d'Ivoire and other countries in the region. Reported cattle volume was greatest at the Niamana market, where 127,545 animals were recorded at the market during the 14-month period. The Kati market followed closely with 101,214 cattle recorded. These volumes were generally 5-7 times higher than volumes recorded at the Gossi, Konna, and Kidal markets (17,477, 18,394, and 1,018 cattle, respectively) in the northern regions of the country for the same period. For sheep, the Kati market near Bamako had the highest volume with 93,170 sheep reported for the 14-month period (Figure 2). The Kidal market in northern Mali had the second highest reported volumes with 61,825 animals for the period. The Kidal market is a daily market and is primarily a sheep and goat market for the region. The Niamana market had the lowest reported sheep volumes for the period. This may be associated with problems that were encountered during 2008 and early 2009 with data collection. Because Niamana is a daily market with a high volume of cattle sold each day, the market monitor had problems with having enough time each day to collect both the cattle and the small ruminant (sheep and goat) data. During this period, priority of data collection was given to cattle. Since July 2009, a second market monitor has been added to Niamana with the primary responsibility of collecting sheep and goat data.

Price differentials occurred at the five markets on a spatial basis and by grade of animal. On a spatial basis for cattle, the Niamana market had the highest average price over the period (175,475 CFA) followed by the Kati (163,114 CFA) and Kidal (150,444 CFA) markets. The Gossi and Konna markets had the lowest average prices for cattle at 114,149 and 114,173 CFA, respectively. The prices at Gossi and Konna were 25 to 35% lower than the other markets and represent a possible opportunity for pastoralists to assess

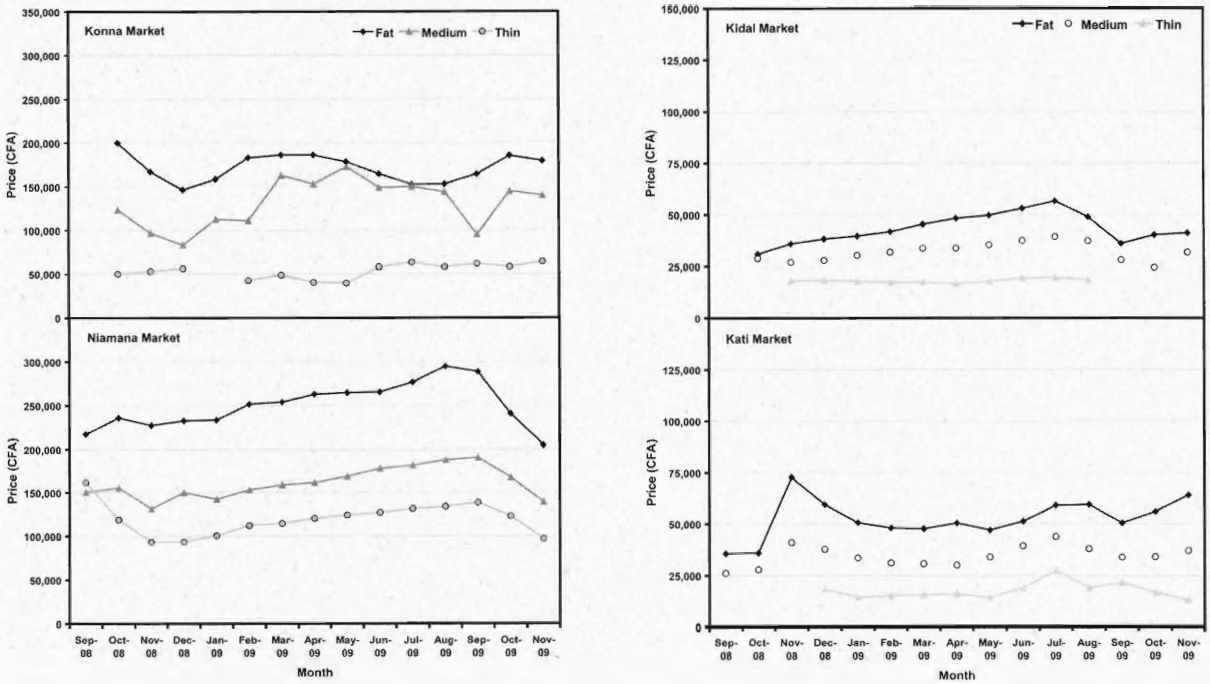

Figure 2. Average monthly prices for the different grades of cattle (fat, medium, or thin) at the Konna and Niamana markets (left); and average monthly prices for the different grades of sheep at the Kidal and Kati markets (right) in Mali (~450 CFA per USD).

whether the additional costs associated with selling animals at more distant markets would increase profits.On a spatial basis for sheep, Niamana had the highest average prices during the period at 63,914 CFA. This was almost two to three times greater than the other markets (Kati, 36,601 CFA; Kidal, 31,006 CFA; Konna, 30,810 CFA; and Gossi, 22,607 CFA). Although there were issues with data collection for sheep at the Niamana market, a comparison of weekly prices at Niamana versus the other markets where data are reported shows that Niamana consistently had higher sheep prices than other markets.

Price differentials between grade (thin, medium, or fat) of mature cattle and sheep were also observed. At the Niamana market, cattle prices for fat grade animals were, on average, 55% higher than medium grade and 110% higher than thin animals. Price differentials also varied over time (Figure 2) with fat grade animals having a maximum of 149% greater price than thin animals during the month of December 2008, and the lowest differential between fat and thin grade animals in September 2008 (35%). Prices for all grades of cattle peaked during August and September 2008, likely due to increased demand for animals for feasts held at the end of Ramadan (*Eid-al-Fitr,* September 20, 2009). Price differentials between fat and thin grade animals were also quite large during this period with fat grade animals bringing 110 to 120% higher prices.

At the Konna market, the price differential between mature fat and thin grade mature cattle was, on average, greater than at Niamana and the other markets, with fat grade cattle having 223% greater price than thin cattle. Differences between fat and medium grade cattle were not as great with two to 76% differences in price over time (Figure 2). Price differences were greatest between fat and thin grade cattle at the Konna market during the latter part of the dry season (February to May 2009) with 280 to 360% higher prices for fat animals (Figure 2). An increase in prices in August and September 2009 was not observed, in contrast to the Niamana market, possibly indicating less demand at this market because of the lower population in Konna compared to Bamako.

For sheep at the Kidal market, fat grade animals brought, on average, 36% higher prices than medium grade sheep and 141% higher prices than thin grade sheep. Price differences between fat and thin grade sheep were greatest during the February to August 2009 period, ranging from 160% to 190% higher prices for fat grade animals (Figure 2). During the September to November 2009 period, no prices for thin grade animals were reported generally indicating that the market monitor could not find enough representative samples (five animals sold) on the market day to report a market price for that grade.

At the Kati market, price differences between grades of sheep were much larger than the other markets, with fat grade sheep having an average 198% higher price than thin grade animals. Price differences were greatest in November and December during both 2008 and 2009. This was likely indicative of the increased demand for fat sheep for the *Tabaski* religious holiday (*Eid-Al-Adha*).

Practical Implications

The implementation of the LMIS in Mali represents the first time that near real-time market information on livestock has been available to the public. The system improves access to market information by providing a simple way to request price and volume information to assist pastoralists, buyers and sellers, and other interested stakeholders in optimizing the marketing of livestock and reducing risk when buying or selling animals. In the past, pastoralists in Mali generally had to rely on word of mouth on prices for livestock and had very little knowledge of price at surrounding markets and the terminal markets around Bamako.

Preliminary results from the initial implementation of the LMIS indicate that prices do vary spatially, and prices are generally higher at the markets near Bamako. Knowledge of this price information allows pastoralists and other sellers of livestock in northern Mali to take advantage of the higher prices at the terminal markets if they are willing to accept the risk and costs associated with transporting their animals to Bamako. As the LMIS development moves forward, we will be developing extension messages and tools to allow pastoralists to assess this risk through estimating transport costs, weight loss during transport, and through examination of the current price trends at the market. Large difference in price due to the grade of animal also provides opportunities for fattening animals as an enterprise. Buying thin grade animals, especially younger animals, and feeding them with high quality supplemental feeds can lead to rapid weight gains. The large price differentials between thin and fat grade animals observed at the markets reported here, can assist in assessing whether the additional costs of feeding and keeping animals for fattening can be recovered. The LMIS information also allows users to assess which markets have the greatest price differentials between grades so that fattening operations could be targeted for specific markets or for specific time periods such as religious holidays.

Kassogue et al. (2009) reported a 73 to 129% valued added return for fattening cattle and a 77% to 233% valued added return for fattening sheep in northern Mali. Market price differentials between fat, medium, and thin grade cattle and sheep reported to the LMIS for markets in northern Mali are consistent with these results. Kassogue et al. 2009 concludes that animal fattening offers the potential for revenue gain in local markets in northern Mali but length of time for fattening needs to be shortened and least cost rations need to be used more frequently. As we continue development of the LMIS, we will be working with other components of the Mali Livestock and Pastoralist Initiative to develop appropriate least cost rations for livestock fattening as well as developing protocols for assessing profitability and risk of implementing fattening enterprises.

Further Reading

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GLOBAL LIVESTOCK CRSP

Animal Fattening in Northern Mali

Sana Kassogue and Boubacar Dembélé, Institut Polytechnique Rural de Formation et de Recherche Appliqué de Katibougou (IPR/IFRA), Mali; and John McPeak, Syracuse University

Mali Livestock and Pastoralist Initiative

Research Brief 10-04-MLPI January 2010

To ensure that the GL-CRSP Mali Livestock and Pastoralist Initiative (MLPI) market information system is of benefit to livestock producers in northern Mali, MLPI has taken steps to link access to market information with livestock production practices that incorporate this information. One area of current research involves the techniques used in animal fattening in northern Mali, where there is a long history of buying animals, fattening them, and then selling them for a higher price. This research was conducted to discover the current practices in animal fattening, the likely areas for recommended production improvements, and how to use extension of improved fattening techniques to build-in an audience that will use the MLPI market information system currently under development. Research was begun with the suspicion that least cost rations were not being used in village based fattening operations, a suspicion that is being confirmed by our findings. Research results are intended to support the development of an extension message that helps livestock keepers reduce costs by minimizing input use in fattening operations, while increasing revenue by employing the MLPI market information system to identify the best options for selling the fattened animals. This also will build on the technical capacity we have supported with the project at Institut Polytechnique Rural de Formation et de Recherche Appliqué (IPR/IFRA) and l'Institut d'Economie Rural (IER) as they provide the scientific analysis that identifies the nutritional content of different feed combinations as well as the relative cost of these rations. Overall, we are hopeful that this work will improve rural incomes, livestock market efficiency, improve animal feed markets, and enhance the technical capacity of our Malian collaborators.

Background

The Mali Livestock and Pastoralist Initiative (MLPI) approach to improving market functioning is based not only on providing producers with information on market conditions but also on enhancing their capacity to act on this information. One way we could ensure that the MLPI market information system is of benefit to livestock producers in northern Mali is to link use of this information to livestock production practices. As an initial step, MLPI has been researching the techniques used in animal fattening in northern Mali, where there is a long history of people buying animals, fattening them, and selling them for a higher price. Improving fattening operations and linking them with the MLPI market information system may afford the opportunity for enhancing rural incomes, especially among women, who are often active in feed markets. MLPI market monitors currently report prices for animals according to categories of thin, average, and fat. Meanwhile, the MLPI website (www.malibetail.net) provides information on prices for animals in these different conditions. Generally, an animal categorized as 'fat' earns 50% to 100% more than an animal of the same type coded as 'average' condition, and more than double the price of an animal of the same category judged 'thin' (Angerer et al., 2010).

To better understand the potential for linking production practices to livestock marketing, we conducted research to discover what are the current practices in animal fattening, what are the likely areas where we can suggest production improvements, and how can we use extension of improved fattening techniques to build in an audience that will use the market information system we are developing. We began this research with this suspicion: least cost rations were not being used in village based fattening operations, a suspicion that is now being confirmed by our findings. Through the knowledge generated by this research, we hope to be able to develop an extension message that helps people reduce costs of animal fattening by minimizing input use, while increasing revenue by using the market information system to identify where best to sell the fattened animals.

Methods

The Institut Polytechnique Rural de Formation et de Recherche Appliqué (IPR/IFRA) de Katibougou developed a survey form in conjunction with input from the MLPI team in December 2008 to collect information on animal fattening practices among 19 individuals and three groups distributed among three sites in northern Mali: Mopti, Sofara, and Koro. From December through January, students from IPR/IFRA (13 students under the supervision of B. Dembélé) conducted the

Table 1. Purchase market of animals for fattening and sales markets for animals after fattening.

Fattening site	Purchase market name	Sales market name
Mopti	**Mopti**, **Fatoma**, Konna, Gossi, Somadougou	**Mopti**, **Fatoma**, Bamako, Lagos, Abidjan
Sofara	**Sofara**, Kouakourou, Mourah, Somadougou	**Sofara**, Bamako
Koro	**Koro**, **Douna**, Sana	**Koro**, **Douna**, Bamako, Domoni, Cotonou

surveys and collected feed samples for later laboratory analysis. Survey data was then pooled and harmonized, and feed samples were submitted for laboratory analysis.

Findings

The findings presented here are considered preliminary, and largely consist of descriptive statistics. One set of questions inquired as to where animals that were fattened had been purchased. Respondents were also asked to identify where the fattened animals were sold. The names of sites where they both bought and sold animals are presented in bold in Table 1; non-bold names (also Table 1) illustrate the difference between buying and selling markets for fattened animals. The differences between these tables indicate that there is potential for a market information system to enhance revenue in this area, as animals are being purchased in local markets and sold in a mix of local and distant markets. If anything, these results would support the development of not just a national, but a regional market information system, as multiple countries are represented in the sale market table. Clearly, knowing information on prices in distant markets has some value to these producers.

Table 2. Sites and species for fattened animals.

Species Fattened	Mopti	Sofara	Koro	Total
Cattle	58	215	54	327
Sheep	-	4	113	117
Goats	-	9	-	9

There are also differences across the sites on which species of animals are fattened. Table 2 presents the distribution of fattened animals across the three study sites. Findings also reveal that there is significant value added as a result of animal fattening (Table 3). As shown in Table 3, there is an average value added return of 157%, with a minimum of 73% and a maximum of 348%. There is no question that animal fattening offers the potential for revenue gain in local markets. The question then centers on the costs of obtaining this gain (Table 4).

Results indicate that while there is variation in practice in the study sites, three main issues have been identified: (1) as suspected, the length of time the animals are being fattened is too long in many cases; (2) least cost rations for fattening operations are not being used, and in particular it

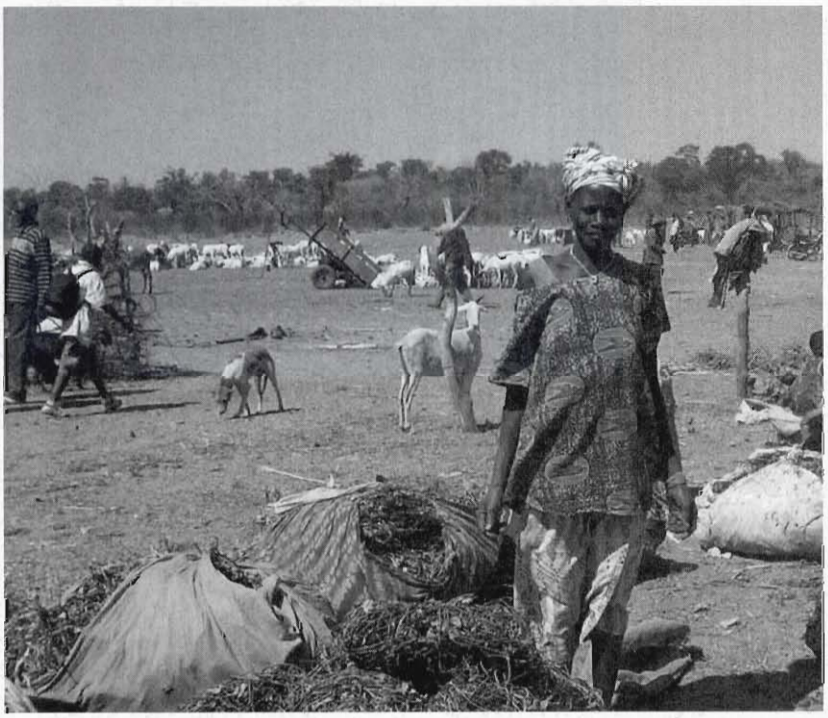

Figure 1. A woman selling animal feed at the Kati feed market in Mali. MLPI research targeting animal fattening operations has the potential to greatly improve rural incomes in Mali, especially for women, who are often active in feed markets. Photo by Jay Angerer.

Figure 2. Sorting animals at Fatoma market, Mali. Research by MLPI suggests that there is potential for a livestock market information system (LMIS) to enhance revenue for livestock producers throughout Mali. The use of a LMIS would allow these producers to obtain better market information in near real-time. Furthermore, results from this study show that there is significant value added as a result of animal fattening, which if combined with improved market information from the LMIS, could offer a means to greatly enhance livelihoods for pastoralists in Mali. Photo by Jay Angerer.

appears that concentrates are being overused; and (3) the concept of tracking input costs in fattening is not very widespread. This provides us with a concrete foundation to move forward in developing an extension message in the field as we enter the coming year. We are working to develop site specific extension messages that will be presented in the three regions of Mopti, Tombouctou, and Gao building on these research findings.

Practical Implications

The evidence supports our initial hypothesis that improved fattening techniques could offer a means to enhance rural incomes and build an audience for the market information system. First, we see that there are spatial differences in where animals are sourced and where they are sold. The market information system we are developing in Mali is designed to allow people to use spatial differences in prices in their marketing decisions. Second, our market information and the information in this survey clearly illustrates that there are gains to having animals in good condition.

From a revenue perspective, it is clear that selling price can be much higher when animals are fattened. The question of cost is the final piece of the puzzle, and where we have

Table 3. Revenue gain due to fattening.

Site	Species	Buying price in FCFA* before fattening	Selling price in FCFA* after fattening	(Selling price – buying price)/ buying price
Mopti	Cattle	92,695	212,350	129%
Sofara	Cattle	91,995	166,380	81%
	Sheep	21,750	72,500	233%
	Goat	6,445	28,890	348%
Koro	Cattle	157,670	272,465	73%
	Sheep	47,185	83,320	77%

**USD 1.00 = approximately 450 FCFA.*

Table 4. Fattening cost estimates for cattle in the three sites.

Site	Feeds per day (kg)	Average No. of days	Cost of feed per kg (FCFA*)	Feed cost per day (FCFA*)	Feed cost for fattening	Feed costs as a percentage of value added (selling price - buying price)
Mopti	14	66	81	1,168	77,088 CFA*	64%
Sofara	17	65	57	957	62,205 CFA*	84%
Koro	10	181	58	609	110,229 CFA*	96%

**USD 1.00 = approximately 450 FCFA.*

begun to make progress as a research team. We are in the field identifying least cost rations, identifying how these may vary across sites depending on the resources available, and developing an extension message that can be presented to local producers. As an added component, this work has linked our collaborators at IER and IPR, and has built in a use for the Near Infra-Red Reflectance Spectroscopy work we have begun with both these institutions. This will foster applied scientific research and develop human capacity in Mali. At the same time, it will provide practical answers to questions of how to increase incomes of rural Malian livestock producers through animal fattening.

Finally, it offers some possible ways to target improving women's income earning opportunities as women are often active in feed markets. As we work to improve fattening, we are also beginning to investigate how we can also improve feed production, storage, and marketing.

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GLOBAL LIVESTOCK CRSP

Management and Use of Bourgou *(Echinochloa stagnina)*

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Bourgou is a type of fodder critical to the livestock production system in northern Mali, that thrives in the inundated areas of the Inland Niger Delta. The bourgou growing zones, or bourgoutieres, *have long played a critical role in the transhumant cycle. Traditionally, bourgou grows during the period when the Delta is flooded and the animals have migrated away to make use of rain fed pastures. The animals return to the delta as pasture and water become scarce in non-flood plain areas, where bourgou serves as a critical fodder through the remainder of the dry season until rain fed pastures become available again. Today,* bourgoutiers *are coming under increasing pressure due to: 1) increased conversion of bourgou growing areas to rice cultivation partially in response to lower flood levels, which have also resulted in reduced productivity among* bourgoutier *species; 2) tension in the management system of* bourgoutieres, *as the traditional* (dioro) *management system is now confronted by an alternative caused by the Malian government's decentralization of natural resource management to the local level; and 3) the growing cash value of the bourgou crop, turning what has been a feed consumed-in-place into a possible cash crop for harvest and sale in markets. Despite these pressures, findings from this investigation show evidence that if bourgou growing areas become degraded, they can still be reclaimed, while areas not suffering significant degradation could experience increased production through improved management. However, preserving and improving the productivity of* bourgoutieres *requires the development of management regimes that provides for their rational use and ensures their long-term viability. MLPI is working to identify how best to support communities to improve management and obtain higher benefits from* bourgoutieres, *in recognition that the pressures currently placed on bourgou growing areas threaten the long-term viability of the resource if solutions are not identified. In addition, ongoing MLPI research is investigating how communities are finding solutions to this challenge, and what can be done to support them.*

Background

Bourgou (the Fulfulde word for *Echinochloa stagnina*) is a type of fodder that is critical to the livestock production system in northern Mali, thriving in the inundated areas of the Inland Niger Delta (Figure 1). The bourgou growing zones, or *bourgoutieres*, have long played a critical role in the transhumant cycle. However today, *bourgoutieres* are coming under increasing pressure. This study was initiated to investigate the current knowledge and subsequent knowledge gaps surrounding bourgou, as well as to assess the changes in bourgou and the *bourgoutieres* since 1960, in order to identify potential management strategies for the viable preservation of bourgou as an integral natural resource for agriculture and livestock production in the area. Sixty people representing various groups who use *bourgoutieres* were interviewed to obtain their views on how the *bourgoutieres* had changed from 1960 to now. Information was collected among older residents of four sites in the central Inland Delta (Koubaye, Sévéri, Walado et Yongari). We also contacted professional organizations active in this area to identify what was currently known about bourgou productivity, regeneration techniques, use of bourgou as a feed, and protection of the resource. Finally, a literature review was conducted to investigate current knowledge on bourgou use and management.

Bourgou grows in hydromorphic soils that are inundated for at least three months and at a depth of at least one meter. Production is reduced when flood levels are low. There are two main types of bourgou: red bourgou, which is sweeter and more commonly used in regeneration (Figure 1); and white bourgou, which is of lower value as an animal feed. In Mali, there are approximately 700,000 hectares of bourgou growing areas. In the Niger Delta, it is estimated that *bourgoutieres* cover 240,000 hectares, or 8.9% of the land mass (Marie, 2000). These are distributed unevenly across the communities. Four communes, Deboye, Toguére Coumbe, and Kewa et Youwarou account for a total of 100,000 hectares. In contrast, 14 other communes in the area have less than 8,000 hectares each. *Bourgoutieres* are abundant in the north, particularly in the area around lac Debo, but also around Toguéré Coumbé, Tenenkou, Mopti, and in the Yongari basin (Marie, 2000).

In the past few decades, the *bourgoutieres* have been suffering significant degradation due to a combination of reduced flood levels and poor management. In spite of these problems, it should be noted that about two thirds of what were historically bourgou growing areas are still productive. The challenge is to keep these

Box 1. Historical management system and prioritization of the bourgoutieres *under the* Dina *code established in 1818 in Mali.*

Livestock production was accorded first priority in the use of *bourgoutieres*. Within livestock production, village *bourgoutieres* called *'barimas'* were allocated for the use of the milking herd, calves, and sick animals, while the remainder of the herd was sent to large *bourgoutieres* away from the village.

After livestock, *bourgoutieres* were allocated to the *Bozo* fishing community. The *Bozo* had temporary camps, *"dagas"* on dryland areas in the *bourgoutieres* used as a base for Delta fishing activities.

Finally, subsistence agriculture was practiced in and around the *bourgoutieres* by *"rimaibes,"* who were historically slaves to the noble *Fulani*.

areas productive, learn from the successful management practices there, and try to extend and reclaim areas where bourgou could be grown.

Traditionally, the management of *bourgoutieres* was collective under the authority of a person called the *'dioro'*. This management system originated in the *"Dina"* code established in 1818 by Sekou Ahamdou. According to this system, a distinct order of priority was established (Box 1). The system described in Box 1 served as a management regime for the *bourgoutieres* up until independence, when the state proclaimed itself the ultimate owner of natural resources in Mali. There ensued a period of confusion, as there was a non-concordance between the traditional management system and the laws being promulgated by the state. In addition, there were changes in land use and overall society; *Bozos* increasingly grew rice, *Fulani* began to practice cultivation, and *Dioros* attempted to turn their traditional authority over *bourgoutieres* into

Table 1. Bourgou productivity in Mopti, 2000.

Site	*Cercle*	Average biomass kg dm / ha
Koubaye	Mopti	5,880
Sévéri	Tenenkou	4,860
Walado	Youwarou	15,030
Yongari	Djenné	5,010

Source: Kodio, 2000.

formal ownership. The decentralization of natural resource management that Mali embarked upon in 1995 has made these tensions particularly acute, but also could offer some opportunities for resolving the management issue. In some areas, there are two different authority structures, *dioro*-based and state-based that claim to manage a given *bourgoutier*.

In this context, it is urgent to establish a new management regime to ensure the future viability of this critical resource. Current research by the Mali Livestock and Pastoralist Initiative (MLPI) is aimed at finding what kinds of local level solutions communities have been able to design in this setting, assess what seems to work, and identify what has not.

Preliminary Findings

As might be expected given such variation in management and production conditions, there is large variation in productivity. Studies indicate the potential of these areas is up to around 35,000 kilograms of dry mass per hectare (kg dm/ha), with a median of around 20,000 kg dm/ha. (Hiernaux et al., 1983) A UNSO project in Tonka in 1989 reported harvests of 15,000 to 32,000 kg dm/ha in

Figure 1. Bourgou (Echinochloa stagnina) *growing in an inundated floodplain in the Niger Delta, northern Mali. Bourgou, and its growing areas the* 'bourgoutieres', *are a critical fodder resource for livestock during the dry season, and have been recently recognized as a cash crop for animal fattening operations. The Mali Livestock and Pastoralist Initiative is working with communities to improve the management of this valuable natural resource, as well as to imporove its utilization and marketability. Photo by Lassine Diarra.*

regenerated *bourgoutieres* after four to five years. Table 1 reports productivity findings from field sites in Mopti.

A management system for each bourgou growing area needs to establish when herds need to leave, when they are allowed to return, which animals will be allowed and which are restricted when animals are allowed to graze, when people are allowed to harvest the grass, when the seeds can be gathered, and what inputs should be applied to maintain the resource. One modification to the traditional system is that permission to graze in a *bourgoutier* has in some places become conditional upon paying a cash fee. Another challenge is that harvesting has become increasingly important compared to grazing in place. Estimates from studies in the area indicate that annual profits from bourgou fields (if marketed) vary from USD 170 per hectare under rudimentary management, to USD 750 per hectare under intense management. In the region of Tombouctou, a mean price of 40 CFA (USD 1 = approximately 455 CFA at time of publication) was reported for a bundle of bourgou straw weighing between 1.5 and 3 kilograms. A different challenge is that harvesting is also undertaken to allow a household to amass a stockpile of bourgou straw. Motivations for this stocking include: animal fattening, feed for increased milk production, dry season supplemental feeding, and possible later sales when prices are high. As such activities draw on a community resource to generate household income, appropriate management structures are needed to ensure the resource is not degraded.

Two other important changes are notable. One involves changes in the species that grow in the area, the second regards the conversion of pastureland to cultivation, in particular rice cultivation. Concerning the issue of species change, residents of the area reported on the kinds of species change they had noted in earlier work conducted in the area. Table 2 summarizes the findings Kodio reported based on interviews in the Inland Niger Delta.

Table 2. Changes in pastures in the Inland Niger Delta.

1960 to 1970	**Since 1990**
Abundant pastures	Undesirable species that have appeared
Echinochloa stagnina (Bourgou) *Panicum subalbidum(Pacri)* *Brachiaria mutica(Bougnari)* *Vetiveria nigritiana* *Andropogon gayanus* *Eragrotis barteri*	*Mimosa pigra* *Typha sp.* *Melochia corchorifolia*
	Species that are increasing
	Voscia cuspidata *Oryza longistaminata (Baw, diga)* *Cynodon dactylon (Koyobon = kesu = gazon)* *Oryza bartii* *Oryza glaberrima*
Present but not abundant pasture	Species that are decreasing
Voscia cuspidata (didèrè) *Oryza bartii(séko)* *Sorghum tricopus* *Oryza glaberrima(farafin malo)*	*Echinochloa stagnina* (Bourgou) *Vetiveria nigritiana (Babin)* *Andropogon gayanus (saran)* *Sesbania rostrata (Porompoli)*
	Species that have disappeared
	(Karso) *(Wadio)* *(Koumba kofol)* *Andropogon spp (Djiguinèbin)*

Source: Kodio, 2000. Words in parentheses represent local names in Fulfulde and/or Bambara.

With regard to conversion of *bourgoutieres* to cultivation, due to a combination of lower flood levels, changes in water management, expansion of irrigation technology, and population growth, there is a significant expansion of rice cultivation onto lands that were formerly *bourgoutieres*.

Zwarts and Diallo (2003) estimate that for the Inland Delta as a whole, almost 1,040 km^2 of the surface was under rice cultivation, which is about the same as the area under a mix of bourgou and *Voscia cuspidata* (*didèrè* in Fulfulde), and more than double the area that is exclusively under bourgou cultivation.

Table 3. Area of bourgoutieres *occupied by agriculture*

Region	***Cercle* de Djenné**	**Tenenkou**	**Mopti**
Sites	Pondori, Yongari, Mangari	Kotia, Diondiori, Diafarabé	Kotia, Sendengué, Pondori, Dialloubé, Sébéna
Total area (ha)	58,800	246,400	175,000
Converted to cultivation (ha)	29,400	122,800	50,000

Source: Kodio and Traoré, 2002.

Practical Implications

Findings from this investigation show that there is evidence that if bourgou growing areas become degraded, they can still be reclaimed. Even for those areas not suffering significant degradation, there is evidence that production can be increased through improved management. Preserving and improving the productivity of the extraordinary natural resource of the *bourgoutieres* requires the development of management regimes that provide for a rational use and ensures the long-term viability of these areas. MLPI is working to identify community-based solutions to these problems, along with how best to support communities to improve management and obtain higher benefits from *bourgoutieres* in recognition that the pressures currently placed on bourgou growing areas threaten the long-term viability of the resource if solutions are not identified. MLPI research in this area has also led to the identification of other issues surrounding the conditioning, storage, marketing, and transformation of bourgou as topics meriting further investigation. It will be our ongoing challenge to identify how to construct or improve the marketing network related to bourgou, and what technologies of preservation or transformation exist for extension to the village level.

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GLOBAL LIVESTOCK CRSP

Risk Mapping for Northern Kenya and Southern Ethiopia

Layne Coppock, Utah State University
Pastoral Risk Management Project

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We used results from 120 group interviews collected in 1998 to quantify how inhabitants across northern Kenya and southern Ethiopia perceive and rank various risks to their livelihoods. We also mapped risk patterns using Global Positioning System (GPS) coordinates. Respondents recognized 15 sources of risk overall, with the most common being reliable access to food and water. Other risks were not mentioned by a majority of respondents and reflected diversity in local situations. Country of residence, wealth class, gender, and predominant means of food production (pastoralism, agro-pastoralism, and farming) influenced risk ranking. For example, wealthy males were most concerned about resource access and livestock prices. Women and the poor were more concerned about access to health services and education and reducing conflict. Risk maps are shown to be useful tools to display patterns of conflict, drought, and related phenomena. Because local problems vary, local solutions to improve risk management will be similarly variable. Participatory approaches clarify local development priorities. Recognition that factors such as wealth and gender will strongly affect risk management priorities should lead to more appropriate and fine-tuned development initiatives.

Background

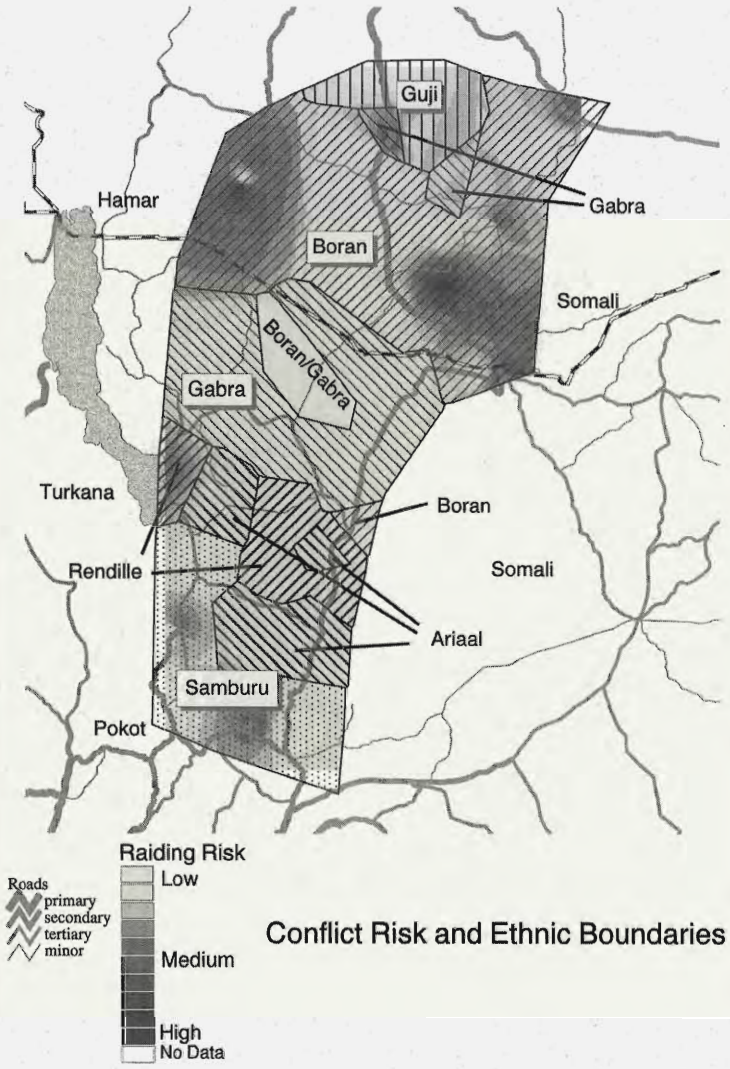
The main research objective of the PARIMA project is to increase our basic knowledge of various types of risk that affect indigenous populations residing in northern Kenya and southern Ethiopia. Better understanding of the complexity and intensity of risk—whether related to drought, market inefficiencies, or insecurity, for example—can improve our ability to prescribe useful interventions for pastoral development.

Our study area is split in half by the Ethio-Kenya border. Our study area is long (about 700 km from Baringo, Kenya, in the southwest to Negelle, Ethiopia, in the northeast) and large in terms of area (roughly 124,000 km^2). Despite that our study area is largely "rangelands" it is variable from place to place. Climate varies from arid to semi-arid and sub-humid largely depending on elevation and landscape features. Our study area is home to about 10 major ethnic groups. Public services are poor, poverty and hunger are widespread, and violence occurs in the form of highway robbery and livestock raiding.

We began our research program with a risk mapping exercise over six months in 1998. We expected that this work would improve our understanding of how various risks are perceived by subject populations and how patterns might be mapped out to aid in better targeting follow-up research and assistance in rural areas. A post-doctoral associate (Kevin Smith) travelled widely throughout the study area and conducted 120 group interviews. The location of each group was noted using GPS (Global Positioning System) coordinates that were transferred to maps. Groups were asked to confer and rank the most important sources of risk that affected

them—risk was defined as "what is worrisome" to respondents and was classified according to incidence and severity. An index was developed that united both incidence and severity—this ranged from a maximum value of 1.0 to a minimum of 0.0. Forty-nine of the respondent groups were from Ethiopia and 71 were from Kenya. Fifty-nine groups were females and 61 were males.

Figure 1: Perceived conflict risk in the PARIMA study area based on 120 group interviews in 1998. Ethnic boundaries were interpolated based on these results and other information.



Major Findings

We found that respondents recognized 15 major sources of risk. The most common worries overall—considering both incidence and severity of impacts—was lack of food and water (index values of 0.56 and 0.53, respectively). These were the only risks mentioned by a majority of sampled groups. Far behind were other risks such as challenges posed from animal disease (0.31), poor access to human health clinics (0.23), low and variable livestock prices (0.15), threats of conflict or violence (0.14), and poor access to schools (0.12). Some of these risks—like conflict, for example—were recognized as important and dangerous when they occur, but they were ranked relatively low because of infrequent occurrence.

There were also influences of country of residence, wealth, gender, and predominant means of food production. For example, compared to the Kenyans, Ethiopians reported relatively more concern about lack of food and poor access to formal education. The Kenyans, in contrast, worried relatively more about reliable access to water, exposure to violence, wildlife damage to crops, access to transport, and being able to pay school fees. Poorer people tended to worry more about the threat of human disease, ethnic conflict or banditry, and crop failure. Females tended to worry more about lack of food and conflict. Wealthier people (and males) tended to worry more about resource access and livestock prices. Compared to farmers, pastoralists and agro-pastoralists tended to have more concerns with regards to lack of food, prevalence of animal disease, and livestock prices. Farmers, in contrast, were most concerned out of the three groups with respect to reliable access to water, human health clinics, schools, and farming inputs.

Some aspects of risk were highly variable across

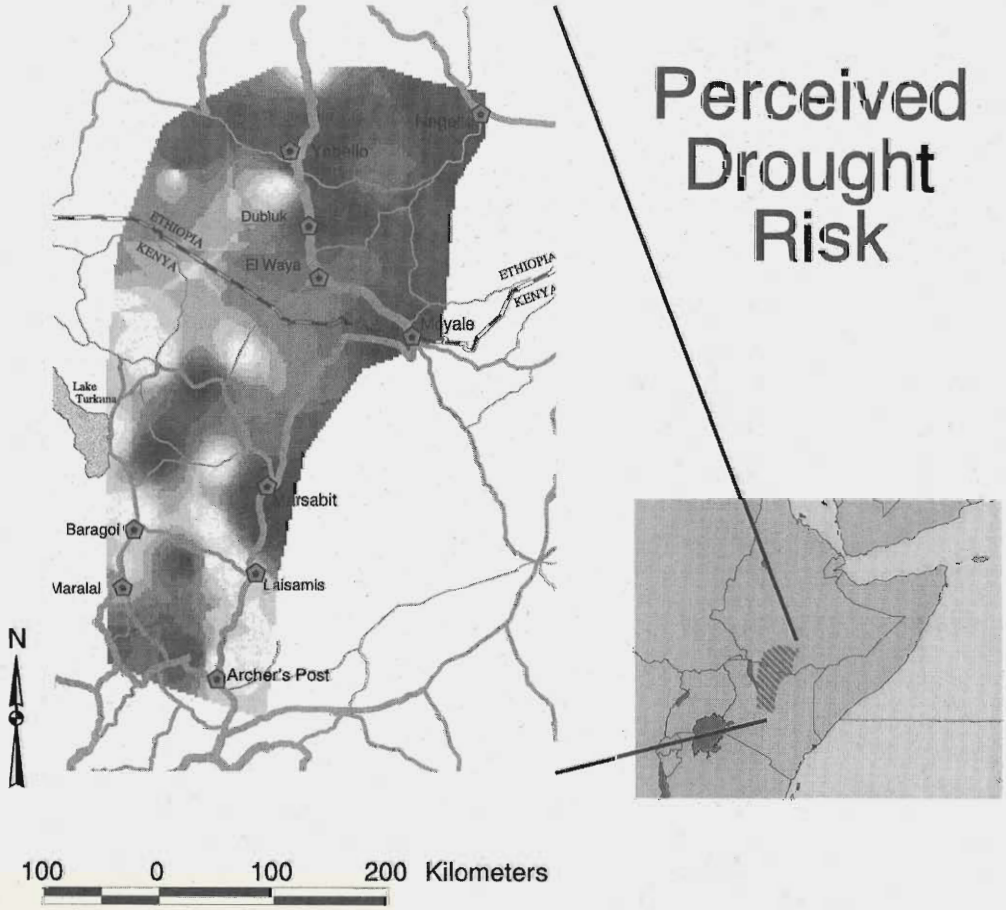
space, and this demonstrated the utility of our mapping approach. Figure 1 illustrates perceived conflict risk shaded in the map according to magnitude of the index (incidence and severity). Conflict risk clearly is magnified along certain ethnic borders. It is notable that this map is the combined output from all 120 sample groups—the conflict map for the 49 groups of females indicated a heightened fear of violence throughout the region compared to that for the males (not illustrated).

Figure 2 illustrates perceived risk of drought. The darker shades indicating greater perceived drought risk correspond to higher elevations throughout the study area, including the Borana Plateau of southern Ethiopia and Marsabit Mountain and the Samburu (Maralal) region of northern Kenya. This is somewhat ironic in that rainfall increases with elevation, and consequently drought should be less frequent for the people who expressed greatest fears about it. The results, however, are weighted by the views of farmers and agro-pastoralists at higher elevations who are more dependent on timely rainfall for cultivation, and who are thus more easily victimized by climate-related risk.

Practical Implications

Given the size of our study area and the diversity of local situations, we found this risk mapping approach to be useful. Our results indicate that in many cases, local priorities for risk management intervention will vary over the landscape. Therefore, local solutions for risk management problem-solving will similarly vary. Participatory approaches are useful to clarify the local initiatives

Figure 2: Perceived drought risk in the PARIMA study area based on 120 group interviews in 1998.



that people are most likely to strongly support. It is unlikely that one standard package of risk management interventions will be applicable to everyone. Gender, wealth status, and primary mode of food procurement affects risk management needs as well, and this should be considered in development strategies. To illustrate the potential for bias, pastoral development priorities have often been in the realm of attempts to improve resource access and use for livestock production and enhance producer prices—priorities of wealthier males. Priorities of women and the poor—such as improved access to human health care, better schools, and conflict resolution—have often appeared less evident in broad pastoral development priorities.

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Design by Susan L. Johnson

GLOBAL LIVESTOCK CRSP

Cattle Population Dynamics in the Southern Ethiopian Rangelands

Solomon Desta, Utah State University
Pastoral Risk Management Project

Research Brief 01-02-PARIMA December 2001

The Borana Plateau of southern Ethiopia is a pastoral region known for producing high-quality cattle. The sustainability of this pastoral system has been recently questioned, however, as livestock losses, poverty, and food insecurity are increasing. We used rainfall records and herd-history data from 56 pastoral households to characterize cattle population trends on the Borana Plateau during 1980-97. We supplemented these data with other findings to update the record through 1999. We wanted to learn to what extent drought and high stocking rates contribute to the high rates of cattle mortality in recent years. We also wanted to estimate economic losses from cattle deaths. Cattle population dynamics resembled a "boom and bust" pattern where longer periods of gradual herd growth were punctuated by sharp crashes in 1983-5, 1991-2, and 1998-9 when 37 to 62% of the cattle population perished. Cattle losses due to periodic starvation regulated the population—net sales or numbers slaughtered were relatively small. When extrapolated to the entire Borana Plateau, the monetary losses of cattle deaths may have exceeded USD 300 million from 1980 to 1997. Separating out the inter-twined effects of high stocking rates and drought on cattle mortality is difficult. We believe, however, that high stocking rates predispose the system to crash when a dry or drought year happens to occur. The higher the stocking rate and larger the annual rainfall deficit, the larger the crash. In some cases a high stocking rate only needs a slightly dry year to cause a crash. System stability appears to be decreasing because drought grazing reserves are reportedly being lost to cultivation, bush encroachment, insecurity, and over-population. We believe that a cattle crash occurs once every 5 to 6 years because this is the time required for the regional herd to grow to over 20 head per square kilometer, and this increases vulnerability. We thus expect the next cattle crash to occur no earlier than 2005. Capturing some of the wealth lost from cattle mortality is important, but the process is difficult. Development solutions could involve aspects of economic diversification for pastoral households if it is sustainable. Improved risk management could involve more timely livestock sales before crisis occurs and investment of some of the revenue into entrepreneurial ventures or community projects. Such system change requires improvements in education, marketing, and rural financial systems.

Background

The semiarid Borana Plateau of southern Ethiopia is an important cattle-producing area in the Greater Horn of Africa. The dominant cattle breed, the Boran, is valued as a hardy, dual-purpose producer of milk and meat. High-quality Borans are sought in domestic Ethiopian markets and are exported to the Middle East and Kenya. The Borana pastoralists are the dominant ethnic group on the Borana Plateau. They number about 325,000 and herd over 1 million head of cattle along with fewer number of sheep, goats, and camels. Although the Borana pastoral system has long been viewed as productive and "successful," there has recently been concern about sustainability of the system due to human population growth, loss of key grazing and water resources, and inadequate development investment. Food insecurity and

poverty are now important problems on the Borana Plateau as they are in other East African rangelands.

We wanted to study the pattern of population dynamics for Boran cattle to determine the scope of wastage mortality and to what extent death losses could be attributed to drought or negative effects of high stocking rates. We also wanted to estimate the economic value of cattle losses using price data for various sex and age classes of animals. Our view was that both drought and high stocking rates were contributing to increasingly regular and catastrophic losses of cattle in the system. Our expectation was that the regional cattle population trend would consist of a "boom and bust" cycle where relatively long periods of gradual herd growth would be punctuated by large, drought-induced losses. It was expected that cattle losses would be most likely to occur when rainfall was low and stocking rates were high. The main data set was based on herd histories covering the period 1980-97 as obtained from detailed interviews of 56 households.

Major Findings

Annual rainfall averaged over the four sites for the 17-year study period is shown in Figure 1. The overall annual mean was 706 mm. The harsh drought of 1983-5 is clearly evident from the data pattern, but it is notable that annual fluctuations in precipitation seem relatively modest after 1986.

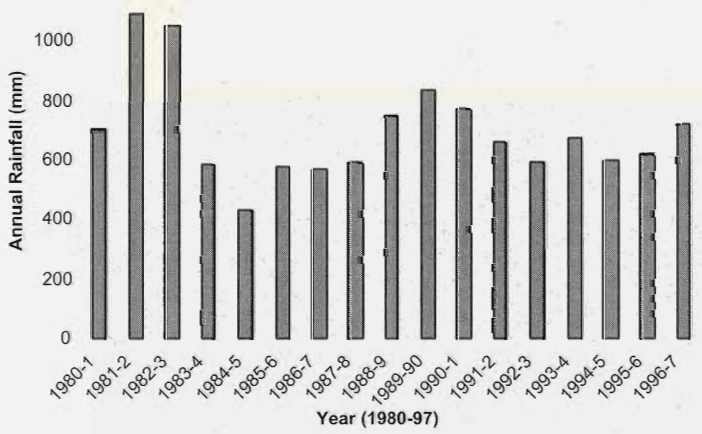
The cattle population trend, as aggregated across the 56 households, is depicted in Figure 2. We observed a "boom and bust" pattern as anticipated. Cattle numbers dropped by 37% after the drought of 1983-5. The herd then quickly grew to about 85% of the previous peak size by 1990. Another crash occurred in the early 1990s with a 42% reduction in cattle numbers, but interestingly the corresponding change in annual rainfall was less apparent in the early 1990s compared to that observed in 1983-5.

It is also notable from Figure 2 that cattle holdings per household declined overall by 37%, implying that people are getting poorer in terms of livestock assets. In 1980 our sample households had 92 head of cattle, and this dropped to 58 head per household by 1997. Net use of cattle for sale or slaughter was only about 2 head per household per year, illustrating that wastage loss from drought-related starvation was the key factor regulating cattle numbers.

The monetary value of the death losses during 17 years was estimated at USD 6,523 per household and USD 893 per person. When extrapolated to 7,000 households in the study areas the total grew to USD 46 million. When extrapolated to the entire Borana Plateau the total losses may have exceeded USD 300 million.

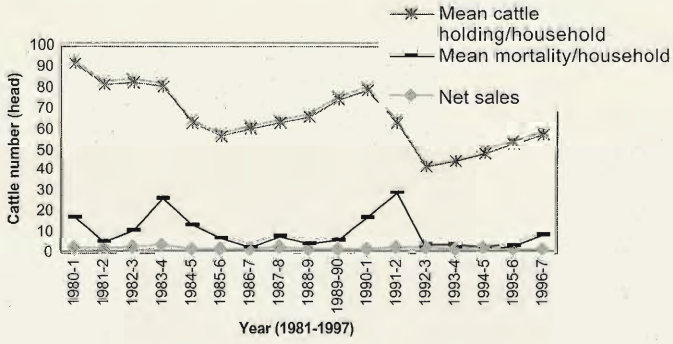
Separating out effects of drought from negative effects of high stocking rates on cattle mortality is difficult using herd history information. We feel the best evidence that both factors

Figure 1: Annual rainfall averaged over four sites in the southern Ethiopian rangelands for the period 1980-97. Source: Desta (1999).



contribute to cattle losses is simply the general pattern of herd dynamics (Figure 2). In looking at, annual rainfall change, estimated stocking rate, and the lagged change in cattle numbers when averaged across the 56 households over 17 years, the important point is how response of the cattle herd appears to have changed with regards to annual rainfall deficits between 1983 and the early 1990s. For example, in response to the 1983-5 drought it took about two years following the initial drop in precipitation until cattle began to die in large numbers—we suspect this lag was due to better availability of drought grazing reserves at that time. By 1991, however, only a small decline in annual rainfall occurred compared to that for 1983-5, and yet a similar number of cattle died. Stranger still, the cattle appeared to die more quickly in response to a dip in rainfall during the early 1990s than they did in response to the drought in 1983-5. We suspect that compared to the drought of 1983-4, the situation in the early 1990s was driven more by a high stocking rate in conjunction with an intervening loss of key grazing reserves in the system. The Boran have reported loss of key grazing areas to us in interviews. The people say that grazing reserves have been lost due to encroachment of cultivation, proliferation of bush, tick infestation that has made some areas unusable, insecurity with respect to conflicts with neighboring ethnic groups, and even occupation of some reserves by surplus Boran households with no other place to live. In sum, compared to the mid-1980s, the entire system appears less able to protect the pastoral population from drought by the early 1990s.

Figure 2: Cattle population dynamics (average number of head per household) aggregated across 56 Borana households for the period 1980-97 and broken-out according to total, total mortality, and net sales. Source: Desta (1999).



After we left the field in 1997 another research project was undertaken in the same general area by Shibru (2001). He surveyed 137 pastoral households during 1999-2000. Shibru found that 62% of the cattle population suddenly died once again during a drought in 1998-9 when annual rainfall was about half of the long-term average.

When we combine our data with those from Shibru we see a pattern—a vicious cycle, actually—where the cattle population now seems to crash on a regular basis every 5 to 6 years. We believe that the period between crashes is primarily determined by the time needed for the cattle population to grow and exceed a critical threshold of about 20 head per square kilometer. Once the herd exceeds this stocking rate, even a modest drop in annual rainfall can suddenly create a "forage crisis" that leads to cattle starvation. If this situation is compounded by a continued loss of key grazing areas, it is conceivable that the time between crashes could shorten. We also believe that the size of any given cattle crash is determined by stocking rate in conjunction with annual rainfall deficits, although this is very hard to detect with our data. We suspect that the higher the stocking rate and greater the annual rainfall deficit, the larger the crash. Each cattle crash may have a different degree of stocking rate effect versus rainfall effect, and relationships may change over time. This makes analysis tricky.

Why do we think that drought alone is not the major factor causing cattle mortality? We agree

that drought or dry years are important "triggering" events, but we suspect that stocking rate predisposes the system for calamity. We believe that drought alone is not the main factor simply because we have seen several years that have been as dry (or drier) than the big cattle crash years of 1983-4. These other dry years were 1986-8, 1992, and 1994. We believe that the reason cattle mortality was low in these years was because the cattle population was recovering from a previous crash. Stocking rates were low at these times.

Practical Implications

Based on the pattern observed for the past 20 years, we expect that the next cattle crash on the Borana Plateau is unlikely to occur before 2005. This information essentially provides a framework for a long-range early warning system.

With a loss of grazing reserves and slow growth in the human population, it seems as though the situation may get worse on the Borana Plateau. Losses of livestock capital are indeed large and may regularly occur for many households. If lost or degraded production resources cannot be restored, the main alternative seems to be finding a sustainable and suitable means to capture some of the livestock wealth otherwise lost to pastoralists. This is a big challenge that would require changes in pastoral livestock marketing behavior and investment in marketing and rural financial systems. It also would require new opportunities for some pastoral households to diversify their economy and improve livelihoods by allocating a portion of their investments outside of livestock. Our prediction for the timeframe of the next crash gives development agents and interested pastoralists a few years to implement creative interventions.

Acknowledgements

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Design by Susan L. Johnson

GLOBAL LIVESTOCK CRSP

Climate Forecasting for Pastoralists?

Chris Barrett, Cornell University
Pastoral Risk Management Project

Research Brief 01-03-PARIMA December 2001

A survey was conducted during 2001 among 323 pastoral and agro-pastoral households in northern Kenya and southern Ethiopia to assess the use and value of "modern" versus "traditional" forms of seasonal climate forecasts in remote areas. Conventional wisdom suggests that forecast information should be very useful for pastoral risk management since accurate predictions could help herders move stock and hedge household risks in a timely fashion. Modern forecasts were received by about 20% of households and this was largely via radio. The vast majority (80%), however, received forecasts generated from various traditional methods, and respondents noted they typically had a high degree of confidence in these predictions. There were several forecast variables of importance to our respondents, but knowing the start date for the rainy season was regarded as most valuable. They said that forecasts are most useful if they could be received with from four to 10 weeks lead-time. Traditional forecasts for rainfall volume for the long rains of 2001 varied from the modern forecasts of the Nairobi-based Drought Monitoring Centre. The Ethiopians tended to be more pessimistic than the Kenyans. Despite a stated confidence in traditional forecasts, few respondents appeared to act on the basis of any rainfall predictions. Cultivators were more likely to respond to predictions of above-normal rainfall, while herders tended to act in response to resource-based, eyewitness scouting reports. There has been a recent upsurge in interest among donors and development agents in improved forecasting and dissemination of seasonal climate information, but our evidence suggests that the anticipated impact of such interventions in pastoral areas may be less than is commonly assumed.

Background

The emergence of sophisticated climate modeling and its apparent successful use in cueing humanitarian efforts that averted drought-related crises in southern Africa has prompted significant interest in climate forecasting for the Greater Horn of Africa. Early warning systems are being developed with the thought that climate forecasts might help pastoralists mitigate risk more skillfully, thereby helping avert crises.

Yet, there is a dearth of empirical evidence as to pastoralists' access to, confidence in, or use of emerging climate forecast information. In the interest of trying to help fill that important empirical gap, just prior to the onset of the 2001 long rains in March we fielded the first round of a brief household survey module on climate expectations and use of climate forecast information. Our goal was to better understand pastoralists' awareness of, access to, and confidence in seasonal forecasts, both locally-based or "traditional" and externally generated or "modern," and to assess the current and potential value of seasonal climate forecasts for pastoralists at their current skill levels. We

surveyed 323 households across 11 PARIMA research sites and complemented the survey with open-ended, qualitative research to establish prevailing indigenous climate forecasting methods.

Preliminary Findings

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

Our households nonetheless hear seasonal climate forecasts, as more than 80% received information based on traditional methods including reading clouds, stars, the moon, livestock intestines, and by observations of livestock and wildlife behavior. Typically, our respondents received traditional forecast information from several sources. For example, 54% of households received information from at least four different sources for the long rains of 2001.

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

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

Modest awareness of, and limited confidence in, modern climate forecasts gives rise to rainfall expectations among our respondents that

Table 1: Overall confidence in forecasts, by type & site

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

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

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

Table 2: Stated probability of rainfall volume for long rains of 2001

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

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

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

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

Practical Implications

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

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Design by Susan L. Johnson

GLOBAL LIVESTOCK CRSP

Pastoralists' Use of Markets

John McPeak, Cornell University
Pastoral Risk Management Project

Research Brief 01-04-PARIMA December 2001

Data collected in the drought year of 2000 from four sites in southern Ethiopia and northern Kenya are used to examine how market access influences livestock marketing behavior of pastoral households. Two sites had high market-access while two had low market access. We hypothesized that market access would be important in helping herders reduce drought-induced losses of stock. Across all sites livestock death rates were high due to drought. We confirmed that better market access was associated with higher rates of livestock sales and probably reduced losses. Better market access also gave opportunities to re-stock when ecological conditions improved. Market access is essential for improving pastoral welfare in our study region. Where market access is good marketing efficiency can be enhanced. Where market access is poor infrastructure investment should be a priority.

Background

Pastoralists in east Africa often face the possibility that there will not be enough forage to support their animals due to poor rainfall conditions. Pastoralists experience high livestock mortality during crisis periods when animals are not removed from areas with insufficient forage through sales or migration. Given the frequency of such losses and the widespread poverty in the PARIMA study area, it is natural to ask how future development efforts can help pastoralists avoid such losses during crisis periods. As mobility is discussed in a separate PARIMA Research Brief, we turn to the question of how markets can be used to adjust livestock numbers to changing forage conditions.

Preliminary Findings

These preliminary findings are based on data gathered between March and December 2000 in 11 sites across northern Kenya and southern Ethiopia. Severe drought made this a difficult period in our study area. Median household herd size over this nine-month period decreased by 25% in Ethiopia and 44% in Kenya. The overall livestock sales rates for households were relatively high by pastoral standards. The annualized sales rate in Ethiopia was 22% and in Kenya it was 12%. However, even with these high sales rates, the observed decrease in herd size was due more to mortality than it was to sales. The annualized death rate in Ethiopia was 43% and in Kenya 53%[1].

Use of markets differs among the study sites, with market access being a key determinant of market use. This is illustrated by considering the following graphs that contrast high market- access sites, Finchawa in Ethiopia and Ngambo in Kenya,[2] with low market-access sites, Dillo in Ethiopia and Kargi in Kenya. The graphs depict data from surveys fielded[3] during June 2000 (or 0600 in the key), September 2000 (0900), and December 2000 (1200) with respect to three different livestock variables: birth rate minus the death rate (br-dr), sales rate (sales), and purchase rate (purchases).

The first implication of these graphs is that, perhaps not surprisingly, higher market access is associated with higher sales rates. On average, the annualized sales rate in the two higher market access sites is 37%, compared to 14% for the two lower access sites.[4] More importantly from a risk management perspective, the ratio of the sales rate to the death rate in higher market access sites is 66%, compared to 24% in the lower market access sites.[5] Finally, we see that particularly in Ngambo, the market is being used for both de-stocking (sales are highest when the birth rate minus the death rate is lowest) and restocking (purchases are highest when the birth rate minus the death rate is highest).

Practical Implications

Market access is a critical factor influencing market participation and risk management by pastoralists. Pastoralists with better market access sell livestock at a higher rate. Marketing played a greater role in modifying herd sizes in high market access sites than in low market access sites during the drought of 2000. Finally, pastoralists with high market access were able to use the market for self-restocking.

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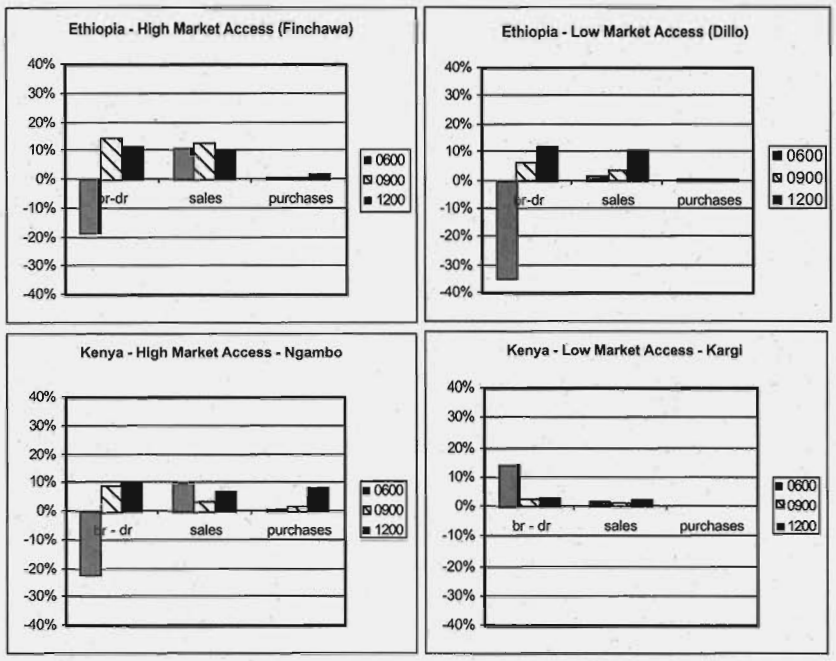
The data from the high market-access sites indicates current market structures are not perfect. Death rates still dominate sales rates and restocking through markets is only significant in one of the sites. However, it is clear that better market access does lead to higher market participation and better risk management. These preliminary findings suggest that the welfare of pastoralists in areas where market access is already high will be improved by investing in measures that increase market efficiency. Welfare of pastoralists currently poorly served by markets will be improved by investing in basic marketing infrastructure.

Figure 1: Contrast of High Market Access and Low Market Access



Footnotes

[1] Measured in Tropical Livestock Units (TLU), where 0.7 camel=1 head of cattle=11 goats =10 sheep. The annualized figures are obtained by multiplying observations for a nine-month period by 4/3.

[2] Both Finchawa and Ngambo are on tarmac roads, while Dillo and Kargi are not.

[3] Sample specific averages are reported for the three-month period preceding the date the survey was fielded.

[4] This is computed by multiplying the average of the six observations (two sites and three periods per-site) of three-month period rates by four. It is also true that the sales level per-period is higher in the high market access sites (0.6 TLU per-period) than in the low market access sites (0.4 TLU per period).

[5] The annualized average mortality rate is roughly the same on average; 56% for the high market access sites and 53% for the low market access sites.

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Design by Susan L. Johnson

GLOBAL LIVESTOCK CRSP

Livestock Pricing and Markets Performance

Chris Barrett, Cornell University
Pastoral Risk Management Project

Research Brief 01-05-PARIMA December 2001

Livestock markets have a very important effect on pastoralists' welfare. We analyzed thousands of livestock transactions in three sites in Kenya to examine market performance. Key findings include: (1) markets can exacerbate climate risks for pastoralists because livestock prices often decline during dry periods; (2) a high degree of inter-market price variability and temporal volatility occur that can lead to lower producer prices and discourage trader and pastoralist market participation; and (3) quarantines are a significant source of producer price risk because they impede commerce in the rangelands. Such problems of market inefficiency could be dealt with by investing more resources in roads, telecommunications, and security in pastoral areas. Alternative methods of animal disease control should also be considered since quarantines have a disproportionately negative effect on poor pastoral producers compared to those for highlands consumers or ranchers.

Background

Since pastoralists hold most of their wealth in the form of livestock, markets for animals exert considerable influence over their livelihoods, both by establishing the value of their assets and by affecting herd management decisions. Livestock markets differ from grain markets in very important ways because live animals are assets that produce a stream of goods and services, while grain is just a good. In particular, changing agro-ecological conditions affect current and future livestock productivity, so even when the underlying price of meat or milk remain stable, the price of an animal can vary sharply. This typically exposes herders to greater risk than crop producers face.

Markets have long been a feature of pastoral systems in the Greater Horn of Africa. But livestock markets in these areas are widely perceived to suffer significant inefficiencies due to high transaction costs, difficulties in contract enforcement, and limited throughput capacity. Problems of low and variable producer prices for livestock rank among the most widespread and serious concerns of pastoralists in the region.

Preliminary Findings

Using data from 63,000 individual market transactions at Marsabit, Moyale, and Nairobi between 1995-8, PARIMA has studied livestock marketing and pricing patterns as they affect pastoralists in Kenya. Several key findings stand out. First, livestock prices and mortality rates are negatively correlated, implying that quite unlike grain markets, price changes do not stabilize pastoralist incomes in the face of productivity shocks. Markets exacerbate rather than ameliorate the biophysical risk livestock producers face. This is most easily seen by looking at how prices change with rainfall. Table 1 shows that even a moderate drought—300 mm below normal over the past year, 200 mm below normal over the past three months—is

Table 1: Estimated Effects of Drought on Livestock Prices (hypothetical drop of 200 and 300 millimeters over 3 and 12 months, respectively)

		PERCENT CHANGE	
	Market	Males	Females
Camels	Marsabit	-3.1	-4.6
	Moyale	-8.1	-11.9
Cattle	Marsabit	-22.1	-52.3
	Moyale	-33.4	-47.5
Goats	Marsabit	-14.6	-17.4
	Moyale	-12.2	-16.3
Sheep	Marsabit	-21.3	-34.1

associated with significant expected price drops, especially for cattle and for females in each species (due to reduced lactation and fertility). Price variability is also decreasing in rainfall. In good rainfall years, prices are both high and stable, while in drought years they are low and volatile.

Second, expected price variation for pastoral markets generally exceeds prevailing interest rates for those with access to credit. For animals whose productivity varies relatively little over the course of a year, (e.g., adult bulls or non-lactating camels or goats), there appears to be significant foregone trading profits, providing indirect evidence of market inefficiency. This seems to be due to relatively high and variable costs of inter-market arbitrage, as shown in Figure 1. By way of comparison, the mean price for adult male cattle in Marsabit over this period was about KSH 6700. The high cost and risk of livestock trading across space arises due to poor communications, poor transport infrastructure, and a high risk of banditry that together discourage trader entry and force them to extract significant risk premia from pastoral suppliers. For animals traded across space, we find that variability in inter-market price differentials (e.g., the Nairobi terminal market price less the Marsabit price) accounts for most of the variability in prices fetched by pastoralists in the rangelands.

Local marketing institutions nonetheless also seem to matter. For animals commonly traded locally—those not destined for Nairobi slaughterhouses—most producer price risk arises due to local market institutions and poor information flow that often leaves pastoral sellers at a significant disadvantage vis-á-vis the traders. Most markets in pastoral areas are dyadic, meaning they involve one-to-one negotiations between buyers and sellers. In theory, auctions should level the playing field, letting pastoralists share in more of the returns from livestock exports outside the pastoral area. In the coming year, PARIMA plans to study this question empirically.

Quarantines are another significant source of

Figure 1: Nairobi-Marsabit Marketing Margins

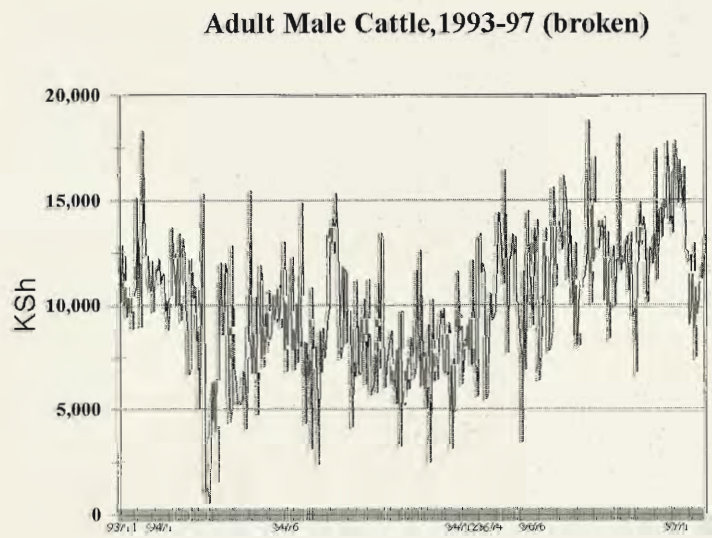

Table 2: Estimated Effects of Quarantine On Prices

	Market	PERCENT CHANGE Males	Females
Camels	Marsabit	-9.1	-6.4
	Moyale	-6.2	-3.7
	Nairobi	0.2	0.1
Cattle	Marsabit	-23.7	-12.2
	Moyale	-16.1	-7.4
	Nairobi	2.4	2.2
Goats	Marsabit	-2.1	-2.4
	Moyale	-1.1	-1.0
	Nairobi	0.4	-0.1
Sheep	Marsabit	-5.9	-2.7
	Nairobi	0.2	0.1

livestock price risk. Most East African governments use quarantines as a primary strategy to control animal disease. Yet quarantines are also explicitly barriers to trade and highland ranchers interested in reducing competition from pastoralist suppliers sometimes promote quarantines for this fundamentally protectionist reason. By impeding commerce, quarantines reduce the prices fetched for livestock from the net exporting, pastoral regions and make remaining market demand and supply more price inelastic, thereby fueling price variability. These effects jointly exacerbate risk and cause substantial estimated revenue losses for herders, as shown in Table 2. Quarantine's effects are generally greatest on male livestock and on cattle, each of which are more commonly sold for slaughter in terminal markets than are females—commonly retained for milking or breeding—or camels or smaller stock, which are more typically slaughtered locally. While we find significant, negative effects of quarantines on the prices received by pastoralists, Table 2 shows that the effects on buyers in Nairobi is negligible, surely because Nairobi draws slaughter animals from multiple locations in the Greater Horn of Africa, so supply blockages in one area due to quarantine are made up for by increased off-take elsewhere. The implication, of course, is that since pastoralists are generally much poorer than highlands beef consumers or highlands ranchers in Kenya, quarantines appear a distributionally regressive means of animal disease control, wherein the poor pay the costs of benefits born largely by wealthier citizens.

Practical Implications

High and volatile inter-market trading margins underscore the importance of investing in improved marketing infrastructure, such as roads and telecommunications, as well as in increased physical security against banditry in pastoral regions. The adverse effects of quarantines on up country livestock markets also suggest a need to explore alternative means by which governments can control animal disease effectively, but perhaps in a more distributionally equitable manner.

Special Acknowledgement

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Design by Susan L. Johnson

GLOBAL LIVESTOCK CRSP

Livestock Trading and Trader Networks in Northern Kenya and Southern Ethiopia

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Pastoral Risk Management Project

Research Brief 01-06-PARIMA December 2001

Livestock trading is important for pastoral economies in the Greater Horn of Africa. To understand how one might improve livestock markets it is necessary to understand the structure and function of marketing chains. One way to do this is to study traders and trader networks. Preliminary work is described here with regards to quantifying some social and economic features of cattle traders who work the long marketing chain between the southern Ethiopian rangelands and terminal markets in Nairobi. Wealthier traders are key players because wealth promotes their ability to mitigate substantial risks of volatile prices, insecurity, poor information, and a weak infrastructure. Likewise, older traders may be more successful because of their experience and higher degree of capital accumulation to buffer themselves against marketing risks. There is evidence of ethnic clusters in cattle markets. Burji, Boran, and Gabra appear to numerically dominate this market chain. Traders in general have a high fluency in several languages, and this may help them to bridge potential barriers related to ethnicity in cattle marketing networks. A majority (81%) use informal networks to secure capital. Only a minority use the formal banking system.

Background

Livestock trading is a very important economic activity for northern Kenya and southern Ethiopia. Understanding how livestock trade operates in the region, and how efficiency could be improved, is essential for improving the livelihoods of pastoral producers. The main hypothesis for this work is that livestock traders in the region engage in different types of social networks to better confront the risks and uncertainties imposed by poor dissemination of market information, a weak market infrastructure, insecurity, and highly volatile livestock prices. It is presumed that many of these network interactions are conducted on a highly personal and individualized basis. Trader networks span the entire marketing chain from production centers in the southern Ethiopian rangelands to the main terminal markets in Nairobi. Since trade in sheep and goats does not require as much investment—and has fewer risks—compared to trade in cattle, it is suggested that the sheep and goat trade entails fewer actors and a lesser degree of personal and individualized trader network interactions than that for the cattle trade. Field research to address these questions began in January 2001 and will continue through April 2002. This work is being conducted as part of the author's doctoral program in Anthropology at the University of Kentucky.

Preliminary Findings

Work thus far has focused on cattle markets and several different categories of cattle such as bulls, cows, and immatures. The major factors that appear to have significant roles in cattle trading networks in the study area include socio-economic (wealth) status, age, and ethnicity of traders.

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

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

Ethnicity is also an important factor in livestock trading relationships. There is some evidence that several ethnic-

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

Traders often rely on personal and informal means to secure resources. For example, only 19% of traders interviewed thus far in northern Kenya use a formal bank account to move money. The majority tend to rely on ethnic-based social networks for cash transactions and holding savings.

The most successful traders have considerable language skills to serve as a bridge between various ethnic clusters. For example, 41% of traders interviewed thus far speak at least 4 languages, 36% speak three languages, and 23% speak two languages or less.

This language facility is indeed a strong indicator of networking potential. The more languages one understands, the easier the process of buying and selling cattle will be.

Practical Implications

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

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GLOBAL LIVESTOCK CRSP

Pastoral Social Safety Nets

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Research Brief 01-07-PARIMA December 2001

It is often presumed that pastoral societies have effective social safety nets to help protect themselves during times of stress. To address this important issue we analyzed quarterly survey data collected among 323 pastoral households residing in northern Kenya and southern Ethiopia during the drought year of 2000. We wanted to quantify the extent to which the households relied on transfers of money, food, and livestock from other pastoralists as part of a social safety-net system. Our results indicate that transfers among pastoralists were very limited during this time frame. Most households appeared to rely on their own resources. In the few cases when households received transfers, they typically came from outside the pastoral sector. Related work by PARIMA indicates that a phenomenon such as drought does not affect all pastoral households in the same fashion—some households suffer much more than others. Despite variation in drought impact at the household level, the capacity for these pastoral societies to internally buffer themselves from stress seems very limited.

Background

Our preliminary hypothesis, based on the anthropological literature and conventional wisdom, was that pastoral societies have strong informal safety nets to help each other in times of stress. When wealth or income shocks differ significantly across households, there is scope for transfer of food, income or assets between households to provide an effective social safety net. If phenomena such as drought impacts are experienced differently among households and the society has a tradition of engaging in significant transfer activities, the need for external resources to assist in drought recovery may be less important than commonly believed. External transfers of assistance have been justified on the basis of a belief that risk in pastoral areas is largely covariate—namely that households are similarly affected by the impacts of climatic or economic stress.

The evidence collected in the PARIMA project so far suggests that the conventional wisdom that risk among pastoralist communities is covariate—that pastoralists' income and assets rise and fall together—is largely incorrect. Herd history data from Borana pastoralists in southern Ethiopia suggests that the covariate component of household wealth risk is modest. Similarly, the quarterly household survey data presently being collected in northern Kenya and southern Ethiopia indicates a wide range of household herd losses, and even some herds that increased in size, during the drought of 2000-2001. Thus, although this drought covered a wide area, it affected households throughout the region quite differently. This then leaves the key question: To what extent do households provide an effective social safety net among themselves?

Preliminary Findings

Our survey evidence suggests that transfers of cash, food, and livestock among pastoral households do not provide much of a social safety net. Based on a preliminary analysis of household survey results for 2000, we find less in the way of cash transfers than we had expected. For example, in two of the Ethiopian communities over 75% of the households reported that they neither gave nor received any cash transfers during the last nine months of 2000—this was when the drought reached its peak and households began struggling to recover (Figure 1). In the other three Ethiopian communities significantly more households (50-82%) were net receivers of cash transfers than net donors. All but one community was a net receiver of cash inflows, reflecting the role of remittances from those outside the pastoral system.

Similarly, in each of the Kenyan communities, at least 58% of the households reported being net recipients of cash transfers, and all communities showed net transfer inflows of cash (Figure 2). Yet, most of the transfer amounts were relatively small. When compared with cash expenditure over the nine-month period, for those that received transfers, the average amount of a transfer was less than 15% of total cash expenditures for all but four of the communities.

Our survey evidence is corroborated by other work done by GL-CRSP researchers in the area. Based on herd history data collected among Boran pastoralists in southern Ethiopia, Lybbert et al. (2001) found evidence of social insurance, but the insurance was surprisingly modest. Instead, Borana households appear to rely heavily on self-insurance through herd accumulation. Similarly, McPeak

Figure 1: Net Cash Transfers, Ethiopia, by site (with 9 month mean, in birr)

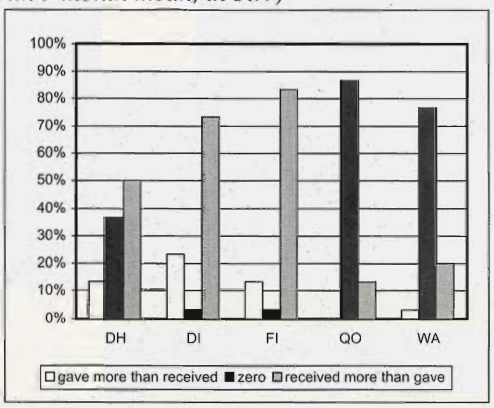
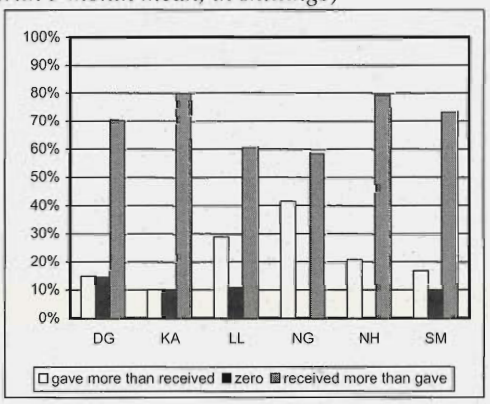


Figure 2: Net Cash Transfers, Kenya, by site (with 9 month mean, in shillings)



(2001a and 2001b) found that among the Gabra of northern Kenya, livestock transfers were of limited effectiveness in coping with livestock losses. He found that past transfer behavior had a significant impact on access to current transfers. The net transfer into a household herd triggered by herd loss is quantitatively very small. Those households who were net debtors over time and who were poor in livestock received very limited transfers.

Practical Implications

There is less of a social safety net than we had expected to find based on the ethnographic literature. Obviously, there are no formal insurance programs available for pastoralists, but we had expected to find that informal institutions filled much of this gap. However, this does not seem to be the case.

Without adequate social safety nets or informal means of insurance, people whose animals die and who lose their sources of livelihood are forced to drop out of the pastoral system. This often has detrimental consequences for those who drop out since they are usually ill equipped to succeed in more urban settings. In addition, there can be detrimental effects to smaller towns and villages in pastoral areas. They cannot absorb an influx of unskilled labor, and their immediate environment can suffer as pastoral drop-outs bring their few animals and concentrate around towns, leading to localized range degradation.

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Design by Susan L. Johnson

GLOBAL LIVESTOCK CRSP

Income Diversification among East African Pastoralists

Peter D. Little, University of Kentucky
Pastoral Risk Management Project

Research Brief 01-08-PARIMA December 2001

Pastoral diversification is defined as the pursuit of any non-pastoral income-earning activity. This includes various forms of trade, wage employment, farming, and gathering and selling wild products. Results from PARIMA field surveys and broader literature reviews concerning pastoral diversification are discussed. There are many reasons why pastoralists diversify, and much local variation in rationale and activities should be anticipated. Wealthier herders may seek diversification to promote economic growth, while the poor may seek diversification to survive. Wealthier herders have the option to pursue things like lucrative trading professions, while the poor are relegated to marginal activities such as fuel wood sales or charcoal production. Diversification options vary according to gender and proximity to towns and settlements. In general, options for women (petty trade) differ from those available for men (wage employment, livestock trade). Salaried employment may be most vital for promotion of food security. Herders residing less than 40 kilometers from towns typically have more alternative income-generating options than those living further away. Diversification is not always the panacea that it is assumed to be. Some forms of diversification may increase risk. Interventions should prioritize promotion of customary resource use strategies (promoting mobility and livestock species diversity) where possible. Medium-term investments should focus on rural education since education is most likely to lead to options for salaried employment. For the settled poor, activities such as dairy trade, sustainable fuel production (forestry), and re-stocking schemes may have the most value.

Background

Livestock herders of East Africa increasingly pursue non-pastoral income strategies to meet consumption needs and to buttress against risky shocks caused by climatic fluctuation, animal disease, market failure, and insecurity. During the past three years PARIMA researchers have engaged in field studies at eleven sites in northern Kenya and southern Ethiopia and have reviewed secondary data and literature that have resulted in several reports, publications, and conference presentations. The work tests the hypothesis that income diversification is an important means of improving risk management by herders.

Pastoral diversification is defined as the pursuit of any non-pastoral income-earning activity, whether in rural or urban areas. This definition includes: (1) any form of trading occupation (e.g., selling milk, firewood, animals, or other products); (2) wage employment, both local and outside the area, including working as a hired herder, farm worker, and migrant laborer; (3) retail shop activities; (4) rental property ownership and sales; (5) gathering and selling wild products (e.g., gum arabica, firewood, or medicinal plants); and (6) farming (both for subsistence and cash income).

Preliminary Findings

Risk is an important reason why herders might

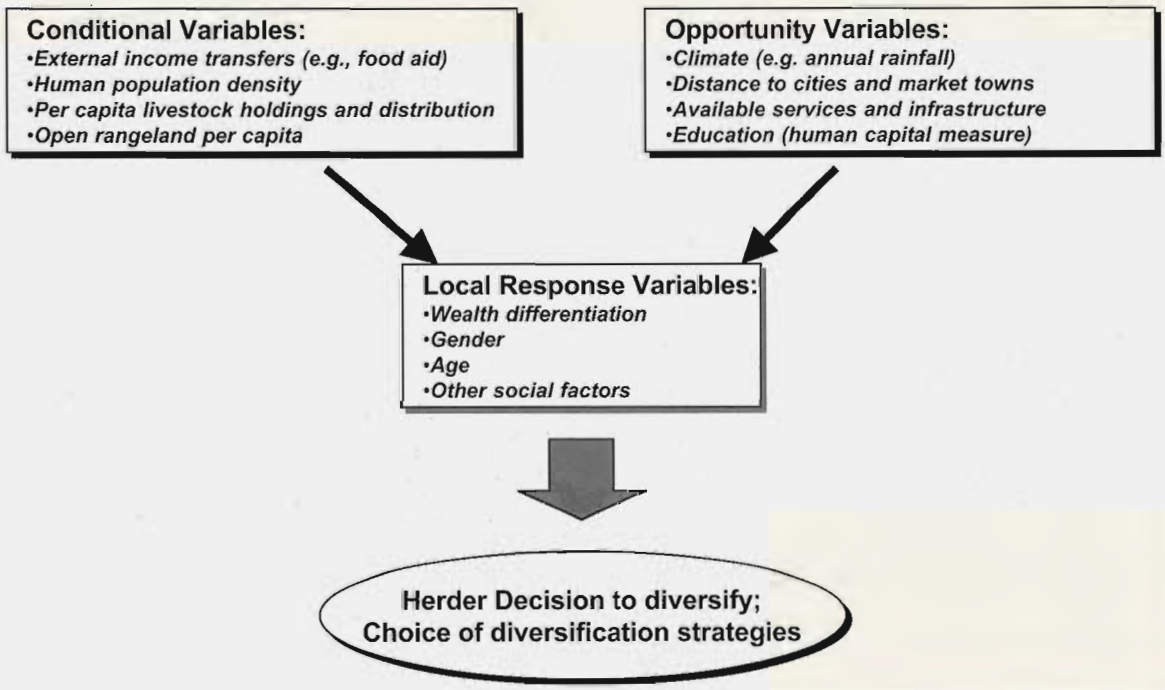
wish to diversify their income sources, but it is not the only reason and in many cases it may not be the most important factor. The causes of pastoral diversification are multi-faceted and resistant to simplistic explanations. Part of the reason for this is that within the designated study area we are dealing with heterogeneous populations and ecosystems. Considerable intra-community differences add to the complexity, in that motivations for diversification vary considerably along both wealth and gender lines. Rich and poor herders pursue diversification for different reasons, and risk may not be equally important for both groups.

Figure 1 shows the interaction of different variables that influence a herder's decision to diversify. For the relatively wealthy herders diversification is a strategy of accumulation or investment; for the impoverished it is a matter of survival. Three different sets of variables are distinguished in the model that influence herder decisions to diversify or not; and what types of strategies to pursue (Figure 2). These include: (1) conditional variables; (2) opportunity variables; and (3) local response variables. Each category can be treated independently, although interactions among them often exist.

Income options vary by proximity to the nearest town and by the gender and wealth category of the herder. Not surprisingly, the closer one lives to a town, the greater the number of options available (Figure 2). Persons living within a 39-kilometer radius of towns mention up to eleven different income activities compared to seven activities for those living more than 40 kilometers away (i.e., more than a day's walk). It also is not surprising that wealthy herders and poor herders have different diversification options (Figure 3). Charcoal and firewood sales, for instance, are income diversification activities done only by the poor. They are extremely laborious and generate little income.

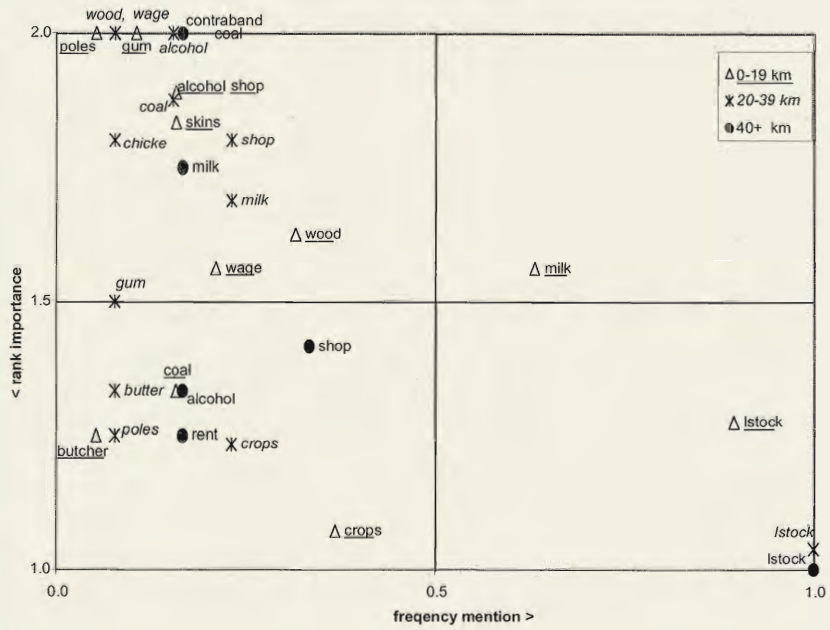
Gender is a socioeconomic characteristic that strongly influences diversification options. Women's main income-earning activities include milk sales, alcohol brewing, and other forms of petty trade, while men frequently engage in

Figure 1: Model of Pastoral Livelihood Diversification



livestock trading. Waged employment is strongly gendered and many of the more lucrative employment options mainly are available to men. Salaried employment has been shown to have an impact on income and food security in our project region. Data from the eleven PARIMA survey sites show that those areas with the highest levels of salaried employment had the greatest influence over cash income and expenditures on food, and the highest amounts of food and cash transfers among households.

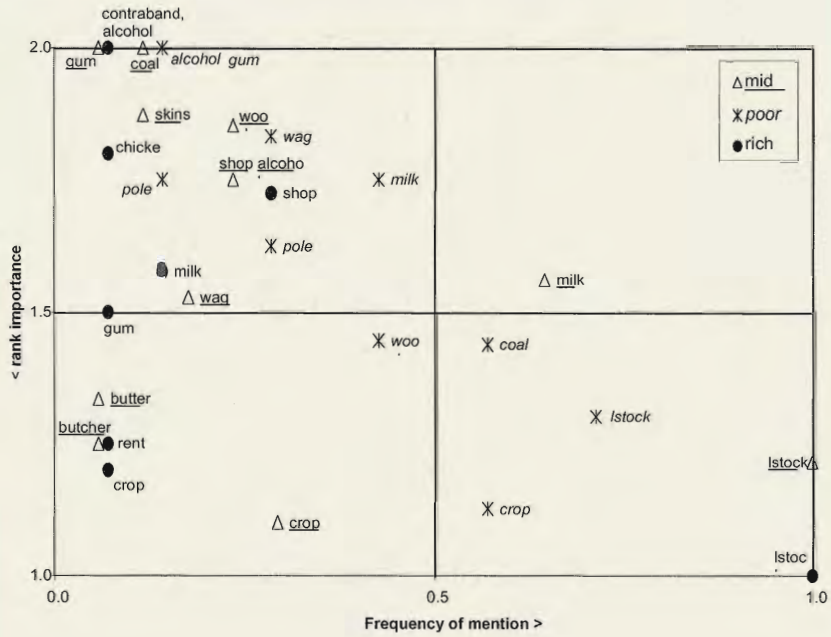
Figure 2: Income Diversification by Proximity to Town



Practical Implications

Diversification is not the panacea that many policy makers assume it to be. The research shows that diversification strategies have multiple causes and most generate low incomes and actually can increase risk during periods of stress. Herd mobility and herd diversification remain the major means of managing risk in pastoral areas and efforts to encourage diversification should not impede these strategies. Investment in education among pastoralists is a viable means of enhancing positive diversification through salaried employment and is a priority on the Kenyan side of our study region. For poor herders and agropastoralists who have already settled options include: (1) Milk trading activities that benefit women; (2) promotion of sustainable forestry activities that generate income through fuel wood and charcoal sales; and (3) restocking schemes that encourage re-establishment of viable herds.

Figure 3: Diversification Options by Wealth Category



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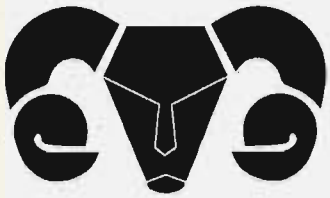


Micro-finance in Northern Kenya: The Experience of K-REP Development Agency (KDA)

Sharon Osterloh, Cornell University
Pastoral Risk Management Project

Research Brief 01-09-PARIMA December 2001

Improving access to grass-roots rural savings and credit options has been postulated as an important strategy to improve pastoral risk management in northern Kenya and southern Ethiopia. Therefore, studies of how rural financial organizations actually work helps us understand the problems and opportunities of such intervention strategies. During 2000-01, the author studied the performance of five recently established Financial Services Associations (FSAs) in Marsabit District, northern Kenya. These are community owned and operated entities that receive support in the form of initial physical assets and on-going audit and training services from the K-REP Development Agency (KDA). The five FSAs range from one to three years in age, and together have nearly 1,000 members. To-date, however, per capita savings remain meager. Loans tend to be small and are used to support consumption as well as investment needs of the population. There are also high rates of loan delinquency. Only a minority of FSA members appear to be active in terms of loan acquisition and managing their savings accounts. If FSAs are to succeed in northern Kenya, we believe that more emphasis needs to be placed on: (1) training of FSA staff and shareholders; (2) research on pastoral economic behavior; and (3) bolstering business skills and non-pastoral investment opportunities in the region.

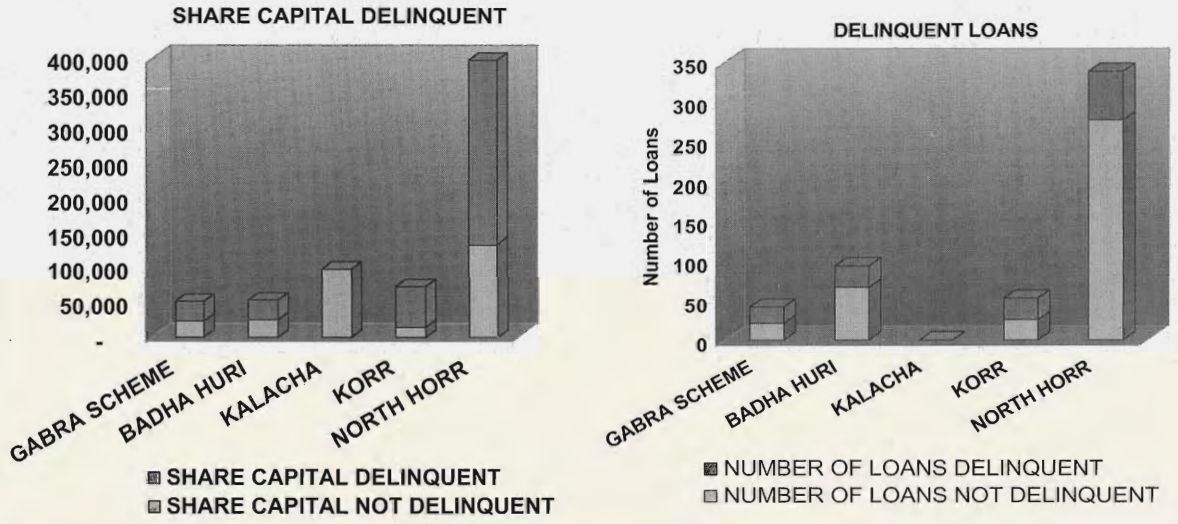
Background

Micro-finance refers to financial services such as cash loans, deposit savings accounts, and insurance made available in relatively small amounts to poorer populations throughout the developing world. Many different forms of micro-finance have emerged worldwide, including in east Africa. This brief presents preliminary findings on one particular type of micro-finance institution, the Financial Services Association (FSA) recently introduced into pastoral areas of northern Kenya by the Kenya Rural Enterprise Program Development Agency, henceforth referred to as KDA.

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

Research has been recently undertaken by the

Figure 1: Delinquent loans as (a) a proportion of share capital and (b) as a proportion of loans disbursed.



author to investigate the performance of five FSAs recently established in northern Kenya. This has involved site visits and interviews of various stakeholders. One theme that guides PARIMA efforts is the idea that increased access to rural savings and credit institutions is an important development intervention for pastoralists. Therefore, understanding how FSAs function (or do not function) in a pastoral rangeland setting is important to evaluate this strategy.

Preliminary Findings

In northern Kenya's Marsabit District, the KDA has launched FSAs that sell shares at KSh300 (about USD 3.80). Share capital constitutes the loan fund as the KDA provides no loan funds per se. The contribution of KDA is purely in the form of initial start-up assets including a strongbox, building subsidy, and bookkeeping materials. The KDA also provides on-going auditing and other training and technical support services. Members of an FSA can apply for loans up to the lesser of four times the value of their shareholdings, or 10% of their total share capital. Members can also open savings accounts up to ten times the value of their share capital. Those who invest more in the FSA can thus save and borrow more.

The KDA has opened five FSAs in northern Kenya. These include: Korr and North Horr (1998), Badha Huri (1999), and Kalacha and the Gabra Scheme (2000). These five FSAs presently have nearly one thousand members, about KSh671,000 and KSh318,000 in share capital and savings, respectively, and more than KSh2.5 million in disbursed loans. North Horr is by far the largest of the five by each of these three indicators.

Loans to date have been small, with a mean of only KSh4800 (median equals KSh2400). This is far too small to provide working capital for an enterprise of minimum-efficient scale in trading or light manufacturing. There seem to be few business opportunities in Marsabit District that are both feasible given the small loans available from the FSAs and profitable enough to support the necessarily high rate of interest charged for FSA loans. As a consequence, more than 40% of loans are extended in support of consumption rather than production activities.

Savings remain meager. Only 48 of the 925 FSA shareholders in Marsabit District have ever made savings deposits. Of these, only 13 accounts have had more than two transactions, namely the initial

deposit and a complete withdrawal. Only one savings account is presently active. Plainly, demand for loans far exceeds demand for savings under present conditions. Pastoralists are not taking advantage of the opportunity to convert livestock wealth into cash savings, even during a period of drought that brought considerable herd stress and relatively high marketed off-take (see PARIMA Research Brief No. 01-04 by John McPeak).

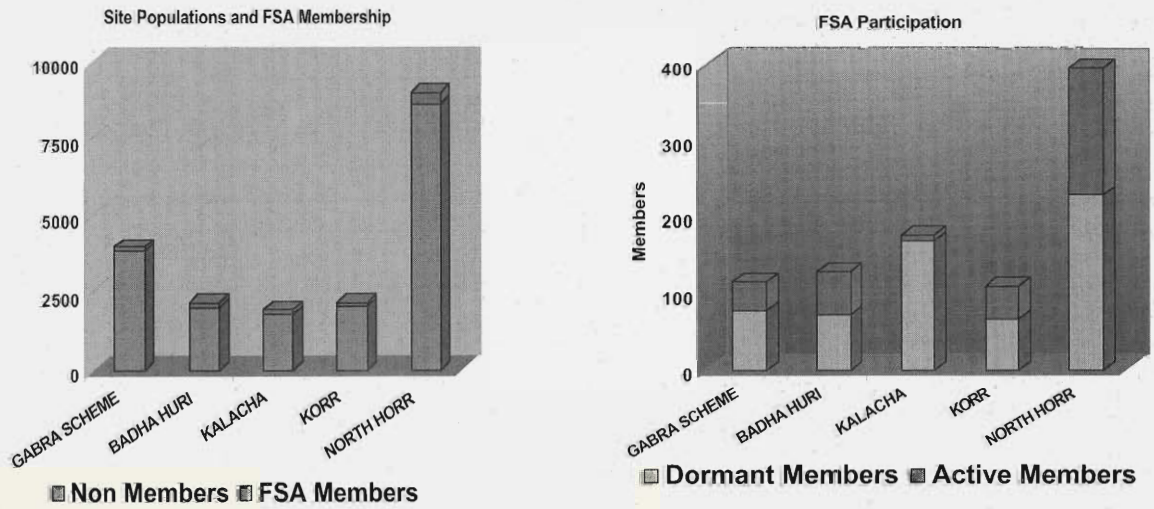
Of the four FSAs in Marsabit District that have been operating at least twelve months, only one shows a profit (North Horr, at 4%). The primary reason for poor initial profitability has been high delinquency for share capital and loans [Figure 1 (a,b)]. Delinquency rates are no greater on loans extended for consumption purposes than those made in support of investment objectives. So, the unexpectedly low repayment rates cannot be attributed to the relatively high proportion of the FSAs' lending portfolio comprised of consumption loans.

Participation in FSAs has likewise proved somewhat less than expected. A small minority of residents in any FSA site purchase shares and thereby become members of the FSA (Figure 2a). Of that minority of local residents who become FSA members, a smaller share still are active, meaning they have taken out loans, opened deposit savings accounts, or both (Figure 2b). Only one-third of FSA members have ever used savings or loan services provided by the associations.

Practical Implications

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

Figure 2: Membership of Financial Services Associations (FSAs) at five sites as (a) a proportion of the local population and (b) active participation as a proportion of total membership.



Special Acknowledgement

We thank the K-REP Development Agency (KDA) for facilitating access to the five Financial Services Associations in Marsabit District. Established in 1985, KDA has emerged as the leader in providing innovative microfinancial services in Kenya. With 58 FSAs spanning the coast to the desert, KDA has introduced financial services to over 20,000 people in rural Kenya.

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Fuelwood Gathering and Use in Northern Kenya: Implications for Food Aid and Local Environments

John McPeak, Syracuse University
Pastoral Risk Management Project

Research Brief 03-01-PARIMA May 2003

As pastoral populations settle, there is concern about environmental impacts of sedentarization. In particular, fuelwood gathering can place intense pressure on local woody vegetation. We report preliminary findings from surveys of 87 pastoral households from three communities in northern Kenya conducted during 2000. The objective was to characterize harvest and use of fuelwood resources. Households used approximately 19 kg of wood daily (largely Acacia spp.). Most wood was used to cook maize. Comparison with findings from an earlier study suggests household daily fuelwood use is increasing in this area. Human dietary shifts associated with increased market involvement and increased provision of food aid —namely moving from milk-dominated to maize-dominated diets— is hypothesized to explain this increase. Experiments were conducted in 2002 to assess amounts of wood needed to cook whole-grain maize versus maize flour, as food aid is distributed as whole-grain maize. Results indicated that twice as much wood was needed to cook whole-grain maize, suggesting that milling food aid prior to distribution could reduce demand for fuel, lower women's labor, and mitigate pressure on woody species. Findings suggest alternatives such as distribution of milled food aid and other efforts will be needed to reduce demand for fuelwood.

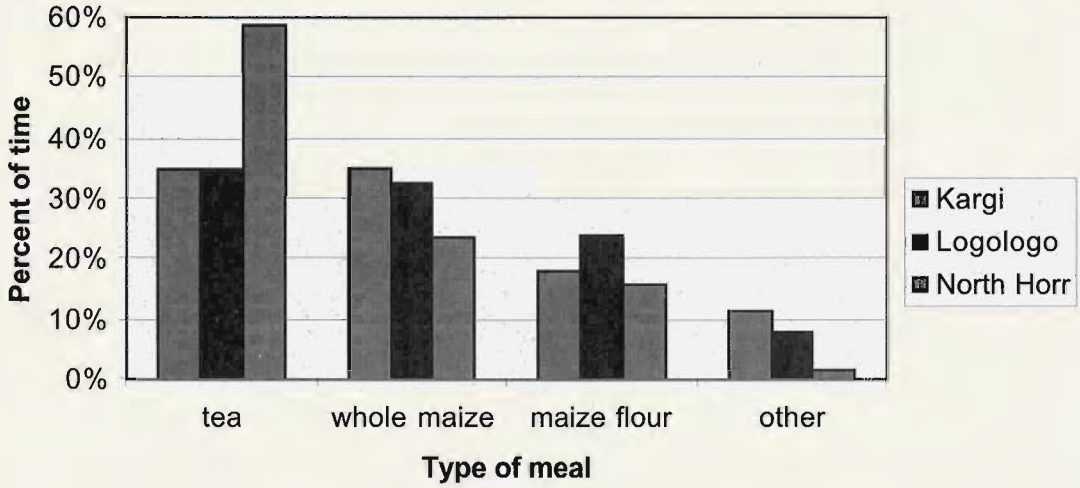
Background

Many researchers in northern Kenya have noted the process by which formerly nomadic populations become settled (Sobania, 1979; O'Leary, 1987; Legesse, 1989; Fratkin, 1991; McPeak and Little, in press). These observers have commented on the rapid growth of small towns in northern Kenya over the past 40 years. The growth of these settlements has led to concern about pressure placed on natural resources surrounding these towns (Walther and Herlocker, 1983; Lusigi, 1984; Keya, 1998). This study was designed to investigate a particular aspect of natural resource exploitation, namely the collection and use of fuelwood for cooking in arid and semi-arid areas. Three of the most arid research sites used by the Pastoral Risk Management (PARIMA) project were selected for this study: Kargi, North Horr, and Logologo. Eighty-seven households participating in an on-going survey to assess socioeconomic dynamics were also interviewed for this fuelwood study during July and August 2000 (the dry season). Each household was visited over seven consecutive days. A total of 608 observations (per household per day) were obtained. The survey recorded information about fuelwood gathering and use. A separate component of this study was conducted in 2002. It involved an experiment to contrast the fuelwood requirements of cooking whole-grain maize versus that for maize flour. A subset of sampled households was monitored for details on cooking various forms of maize. Information on cooking time and fuelwood use was recorded. There are 20 paired cooking observations in the analysis.

Preliminary Findings

- Of 238 fuelwood gathering trips recorded, only one was undertaken by a male. Fuelwood gathering is thus an activity of female adults and children.
- Fuelwood gathering took place about once every three days on average. The average trip took three hours.
- People carried wood back home themselves 98% of the time. Camels and donkeys were used for the scant remainder. Wood gathering was dominated by use of machetes (60% of trips), breaking wood by hand (37%), or using an axe (3%). About 1.6 woody species and 48 pieces of wood were gathered per trip.
- *Acacia* species (primarily *A. reficiens, A. seyal, A. tortilis,* and *A. mellifera*) accounted for 57% of wood gathered. The next most common genera was *Suaeda* (*S. monoica* is gathered exclusively by North Horr area residents), accounting for 11% of all wood gathered. A variety of other species made up the remainder.

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



- The average daily fuelwood inventory per household was 19 pieces weighing a total of 12 kg. The average weight per piece was almost 1 kg.

- For 16% of 608 daily household observations, households borrowed fuelwood from other households, while a similar number gave fuelwood away. For 10% of observations households had purchased fuelwood, while for 4% of observations households sold fuelwood. For 1% of observations charcoal or other fuel was used for cooking.

- The average household used 19 pieces of wood per day for cooking.[1] The largest number of pieces per day (9) was used for cooking whole-grain maize. The second largest use of wood (6) was for cooking tea. Meals based on maize flour used 3 pieces of wood per day on average, while all other uses accounted for 1 piece per day on average.

- Overall, we find that while 43% of times the stove was used, tea was cooked, the wood used for this purpose only accounts for 27% of total daily fuelwood use. In contrast, although 31% of uses were to cook meals based on unshelled maize, these meals used 40% of fuelwood. Figures one and two contrast measures for the percent of stove use and percent of wood use ·r site for each of the different types of meals.

- The cooking experiment indicated that cooking an equivalent amount of whole- grain maize required roughly twice (1.97) the wood required to cook ground maize.

Practical Implications

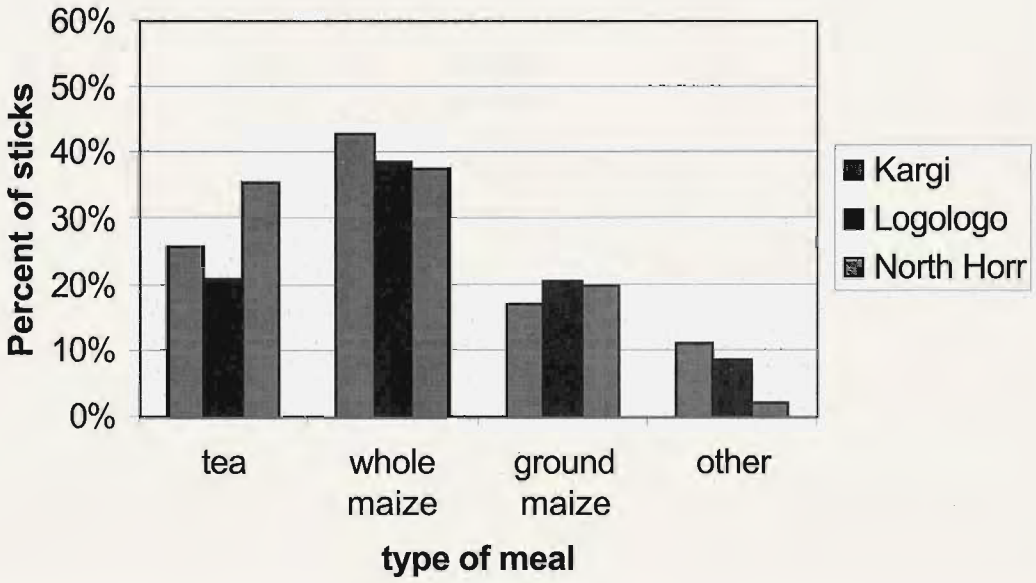
Results are preliminary and will be refined as the analysis proceeds. However, it appears that sedentarization has a two-fold impact on fuelwood resources.

First, pressure is localized on woody resources around towns and settlements. Recall that the average wood gathering trip lasted three hours, and on the return leg the average load carried on a woman's back was in the 40 to 50 kg range. Neither vehicles nor animals played a significant role in fuelwood transport. There is little reason to believe the distance of the collection point from town has changed much from the estimate of 2.5 km forwarded by Walther and Herlocker (1983).

Second, there appears to be a subtler impact brought about by a dietary change from a milk-based to a grain-based diet. The grain-based diet increases fuelwood requirements of households.

These two factors lead to three main practical implications.

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



First, we determined that a diet based on whole-grain maize required more fuelwood than one based on ground maize. Recognizing that food aid in this area is distributed as whole grain maize allows us to estimate that a switch in food aid composition from whole-grain to ground maize could reduce fuelwood requirements up to 4% per year and reduce the amount of time women spend gathering fuelwood up to 6%. These figures are estimated by utilizing information in the repeated surveys that record total annual food aid packages received by households and calculating the reduction in wood requirements and use if whole-grain maize had been instead distributed as ground maize. This suggests that food aid distribution in the form of maize flour could reduce both women's labor and mitigate the rate of depletion for woody resources.

Second, more attention should be given to linkages among increased market involvement, dietary change, and higher fuelwood use among settled pastoralists. As pastoralists become increasingly involved in selling livestock and livestock products to purchase grain, pressure on local woody resources can increase. This would occur even in the absence of any increase in human population for a given area, and would be exacerbated where human population growth occurs. While there are some methodological differences in approaches taken, our estimate of household fuelwood use of 19 kg per day is over six times higher than that of Walther and Herlocker's (1983) finding of 2 to 4 kg per day. This suggests that household fuelwood use in northern Kenya has dramatically increased over a 17-year period. We are currently comparing our data with data Walther and Herlocker's (1983) findings and other UNESCO-sponsored research in this area to help understand what may have led to such a rapid increase in fuelwood use by households.

Third, there is reason to question the sustainability of current use patterns. As suggested by Keya (1998), there is evidence that woody resources near pastoral settlements are decreasing due to overuse. Research into efforts to better manage fuelwood is critical, from the demand perspective (improved cooking and food preparation techniques) and the supply perspective (protection of existing woody resources, planting of new woody resources).

Footnote

[1] There is consistency between the results for how many pieces of wood were gathered per week and how many pieces were used per week. Results indicate that households collected or used 131 and 133 pieces per week, respectively.

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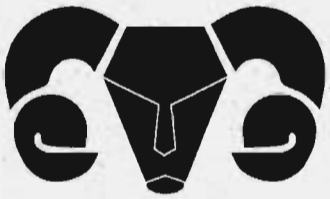

Pastoral Sedentarization and Community Resilience in Response to Drought: Perspectives from Northern Kenya

John McPeak, Syracuse University
and Peter Little, University of Kentucky
Pastoral Risk Management Project

Research Brief 03-02-PARIMA May 2003

Pastoral sedentarization is a major trend in East Africa, and there is debate about its social and ecological costs. Here we discuss relationships between sedentarization and well-being for pastoral households in northern Kenya. We used survey data collected from six sites from March 2000 to October 2001 in addition to other information sources. There are varied degrees of sedentarization and complex relationships among vulnerability, sedentarization, mobility, and household income diversification. First, we find that sedentarization does not necessarily reflect a complete departure from pastoralism, nor does it always jeopardize pastoral production. Second, sedentarization does not always imply a loss of access to livestock, nor a lack of mobility for livestock owned by settled households if satellite camps are maintained. Third, there is a great deal of diversification into non-pastoral activities by members of households while other members can remain engaged in mobile pastoralism. Lastly, there is a need to distinguish between increased vulnerability to livestock loss and increased vulnerability to food insecurity when households become sedentary. Overall, we find that what is often labeled sedentarization need not be antithetical with pastoral production. Households show great adaptability and innovation in adopting non-pastoral activities without fully abandoning mobile pastoralism. Three key recommendations that assist pastoralists to maintain mobility and sustainable lifestyles are: 1) educational facilities closer to key grazing and watering points; 2) mobile para-vet services; and 3) land tenure policies that allow access to key resources critical to pastoralists.

Background

Increased sedentarization of pastoral populations has characterized most arid and semi-arid regions of the world during the past two millennia. The origins of many urban areas in the Middle East, North Africa, and the Sudan stem, in part, from the historical process of pastoral sedentarization, whereby segments of mobile herders sought refuge or economic opportunity from settled life. Sedentary livelihoods have always been a survival strategy for impoverished pastoralists, while wealthy herders have pursued urban lifestyles to promote new investments and engagement in more lucrative economic activities (retail trade, irrigated agriculture) compared to the poor. The accelerated settlement of herder populations in sub-Saharan Africa during the past century provoked claims of "an end to pastoralism." Diversification into town-based activities was seen as a departure from pastoralism, rather than a supplement or peripheral support (Government of Kenya, 1980; Snow and Morris, 1984). Northern Kenya is unique in this respect since most settlements and towns have only arisen in the past 50 years or so, and mobile pastoralism still characterizes large parts of the region. Increased sedentarization in the area also reflects a series of external influences, such as the widespread proliferation of food aid and other forms of development assistance, which complicates an understanding of longer-term trends toward settlement. It also raises the question as to whether or not increased sedentarization among herders in the region really reflects an enduring commitment away from pastoralism or not.

Major Findings

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

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

Table 1: General features of sites studied by the PARIMA project in N. Kenya.

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

In contrast to Ngambo, although the average household at **Dirib Gumbo** lost over 80% of their livestock during the 1999-2000 drought, their well-being does appear to have been negatively affected by that drought. Although Dirib Gumbo is not distant from the major market town of Marsabit—and people at Dirib Gumbo have relatively high levels of education—they also have a relatively low share of their income from non-pastoral sources. Salary, wage labor, and trading account for only 30% of household income at Dirib Gumbo. This is probably because most of these households rely on rain-fed agriculture in "normal" years and seem to have relatively poor access to some types of wage employment. When the rains failed during the 1999-2000 drought, many of the households sold livestock to meet consumption needs, which may explain why the share of income from livestock and livestock products is relatively high.

The average household in **Sugata Marmar** was not severely impacted by the drought in terms of livestock loss, food insecurity, or income. Partially, this may reflect the fact that rainfall data from the area suggest drought was less severe in Sugata Marmar than in other areas of northern Kenya. It may also reflect the fact that households in Sugata Marmar have access to income-generating opportunities arising from a large weekly market. They also live close to markets where food can be purchased. Households in Sugata Marmar earn a relatively higher share of their income from trading (25%) compared to that from any other site. Combined with income earned from selling their own livestock and livestock products (45% of income), residents of Suguta Marmar earn considerable revenue from trade. The mobility of livestock in this area differs from that in others—perhaps because there are more water points available in the Samburu grazing lands. By relying on satellite camps and multiple established households (i.e., a family head with multiple spouses maintains at least one domestic dwelling near an education facility), families at Suguta Marmar appear to have found a compromise between mobility and education, as is seen by the relatively high rates of school enrollment.

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

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

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

Practical Implications

Income diversification is frequently discussed as an alternative to pastoralism. Our findings suggest it may be more useful to think of how income diversification can be used as a supplement to pastoralism rather than a

replacement. Thus, the key is to provide sedentary-type services (for example, education and veterinary services) that benefit pastoral populations without jeopardizing mobile pastoralism and creating unwanted concentrations of people and animals around fragile settlement environments.

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

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

Land Tenure and Planning. Increased sedentarization can aggravate land conflicts in the vicinity of settlements. This often pits local groups against new immigrants and herders

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

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

Notes:

1 *Defined using household level, two-week expenditure data and adding in the value of two weeks worth of home-consumed milk defined using the local market value of milk. The maximum is $31, the minimum $10.*

2 *Defined as the household-level coefficient of variation over time periods for the measure described in (1). The maximum is 78%, the minimum 50%.*

3 *Defined as total household cash income for a three-month period. The maximum is $125, the minimum $32.*

4 *Defined as the share of the measure described in (3) that is not accounted for by livestock or livestock product sales. The maximum is 82%, the minimum 40%.*

5 *Defined in terms of Total Livestock Units. The maximum is 20, the minimum 2.*

6 *Defined as the maximum decline in the average of the household observations for (minimum herd size / maximum herd size)-1 during the period March 2000 to September 2001 of the measure used in (5). The maximum is -85%, the minimum -5%.*

7 *Defined as the average number of water points visited by a household herd over a three-month period. The maximum is 3.3, the minimum 1.1.*

8 *Defined as the percent of school age children who were enrolled in formal schooling in 2000. The maximum is 91%, the minimum 16%.*

against farmers. Agricultural encroachment onto rangelands has been associated with certain patterns of sedentarization and can instigate conflicts related to land use and tenure, often to the disadvantage of local herders. Policies should be developed that recognize the rights of herder groups to customary water points and grazing areas and delimit the extent to which sedentary farming can expand into rangelands.

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The Global Livestock CRSP is comprised of multidisciplinary, collaborative projects focused on human nutrition, economic growth, environment and policy related to animal agriculture and linked by a global theme of risk in a changing environment. The program is active in East Africa, Central Asia and Latin America.

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Design by Susan L. Johnson

GLOBAL LIVESTOCK CRSP

For Pastoralists the Risk May Be in the Drinking Water: The Case of Kargi, N. Kenya

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Inadequate quantity of water is a common problem for pastoral people in East Africa. For the Rendille community of Kargi in northern Kenya, however, water quality has also been identified as a critical issue. Residents report that water-borne diseases commonly affect human health in dry seasons, and livestock may die soon after drinking water from some of the older, deep wells. We collected water samples from four key wells and one earthen dam to analyze physiochemical and bacteriological quality. Preliminary results indicated that the centrally located, oldest wells tested far below technical quality guidelines in several respects. Especially notable were the very high mineral content of the water and the presence of toxic bacteria (Salmonella spp., Escherichia coli). Low concentration of oxygen in the water from old wells—in combination with the presence of Salmonella –may promote production of potentially lethal gases like hydrogen sulphide. In contrast, water quality in younger wells and the earthen dam—all further from Kargi town—more commonly met technical guidelines overall, but evidence of bacteria from fecal contamination was still detected. As settled populations of pastoralists grow in the absence of infrastructure development, dangers of water contamination and water-borne human illness increase. Community-based interventions to better manage water quality are reviewed. A simple, low cost solution is proposed.

Background

When pastoral people are surveyed and asked to rank their most important problems, lack of water is commonly mentioned (Smith et al. 2000). The PARIMA project helped coordinate an exercise in Participatory Rural Appraisal (PRA; Lelo et al., 2000) during 2001 at a Rendille community called Kargi, located about 80 km southwest of Marsabit Mountain in arid northern Kenya. The full PRA revealed that lack of safe, clean water for consumption by people and livestock was perceived to be a priority problem by the community (Desta and Godana, 2001). People reportedly commonly suffer from water-borne illnesses—especially during dry seasons—such as typhoid, cholera, and dysentery. A massive die-off of livestock was noted in 2000 when over 1,000 animals perished soon after consuming water from an old well. Community residents generally perceive a significant risk of death for animals when they drink from some of the local water sources at certain times of the year. The animals may bloat and die within an hour of drinking. The cause of poor water quality was unclear, however, and the community had many theories as to why (Desta and Godana, 2001).

Kargi was a single water point in the 1920s, but started to become a small town by the early 1970s when Rendille nomads settled (Shivoga, 2002). Kargi now has about 5,700 people living under difficult conditions that include a lack of infrastructure, high levels of illiteracy and physical insecurity, and prevalence of drought. In the past 30 years some 20 wells have been dug in and around Kargi, but today about seven remain fully functional in terms of adequate water flow or minimally acceptable water quality (Desta and Godana, 2001; Shivoga, 2002).

As a first step to address water quality problems at Kargi, we decided to analyze water samples from five key water points for physiochemical and bacteriological features during April 2002. We followed standard procedures of APHA (1992). Water samples were taken from a number of sources. Some were collected from two centrally located wells (called Kargi and UNESCO Wells) that are up to 9 meters deep and over 50 years old. The rest were collected from two younger, shallower wells (called School and Hadad) and an earthen dam (called Kuya) that accumulates surface water. In contrast to the two old wells, these three other water points are located further from the core settlement zone of Kargi.

Preliminary Findings

In general, the water quality from the older wells was revealed to be very poor in both physiochemical and bacteriological features. Results for selected parameters are shown in Table 1 along with technical quality guidelines from ACCC (1999). The full spectrum of test results is given in Shivoga (2002). Particularly notable are the very warm temperatures of well water (due to residual volcanic influences), the high mineral content

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

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

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

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

of water, and presence of toxic microbes. Microbes included fecal coliforms, *Salmonella* spp., *Escherichia coli*, and possibly *Shigella* spp. Shivoga (2002) speculated that ambient conditions in the old wells could be conducive to the manufacture of hydrogen sulphide gas (H_2S), a potentially lethal compound produced by *Salmonella* microbes when oxygen concentration of water is low and free sulphur is abundant. This could explain livestock mortality risk after drinking well water, but requires further investigation (Shivoga, 2002). Low oxygen concentrations in well water can be promoted by warm water temperatures and restricted aeration.

The water quality from the younger wells and the Kuya Dam was a bit better compared to that of the old wells. Although salinity and total mineral content was often high for the School Well, only a trace of *Salmonella* was detected in bacteriological analysis. Blooms of blue-green algae (Cyanobacteria) were also visually noted on the walls of the School Well, and some species of this microbe family can be toxic (Shivoga, 2002). The younger wells and Kuya Dam exhibited evidence of fecal contamination from coliform bacteria, even though presence of *E. coli* and *Salmonella* spp. tended to be lower than values for water from the old wells (Table 1).

Practical Implications

Water quality for the old Kargi and UNESCO Wells is very poor for human—or even livestock—consumption. One factor that contributes to this situation is probably the central physical location of these wells in relation to the town and low position on the landscape. Rare but severe rainstorm events could help funnel human and animal waste into the water supply for these wells. It is doubtful whether the water quality from these old wells could ever be restored to meet minimum standards for human consumption. Catchment systems could be constructed that would help channel waste water away from the aquifers serving the old wells. Water intended for livestock consumption could be drawn from these wells and left to stand overnight in open troughs to allow evaporation of potentially toxic gases like hydrogen sulphide (Shivoga, 2002).

Water quality from the younger School and Hadad Wells and the Kuya Dam was somewhat better compared to that from the old wells, and validates why these water sources tend to be highly valued by the community (Shivoga, 2002). The improved condition of these water resources is probably related to factors that include the physical location of these water points and attention given to excluding animals from the immediate vicinity. The younger wells and Kuya dam are located away from concentrated human settlement. The Kuya Dam, in particular, is protected by a strong thorn fence to keep animals out. This also helps keep animal waste from collecting in the vicinity. The presence of fecal coliforms at each of these locales, however, means that the community must still be vigilant.

The community could be trained to monitor water quality using simple test kits and hence have an early warning system to detect problems before they overwhelm the system (Shivoga, 2002). While the high mineral content of water in general appears to be a given due to geology and is not amenable to improvement, a simple system for "pot chlorination" could be implemented to eliminate dangerous microbes, especially at the younger wells having smaller water volumes (Shivoga, 2002). That such microbes pose community health risks is an understatement. Microbes such as fecal coliforms are associated with diarrhea, vomiting, and dehydration. *Shigella* spp. can be associated with dysentery. Strains of *E. coli* are associated with acute systemic poisoning, and chronic exposure can lead to permanent health complications. *Salmonella* is a genus that leads to a variety of very debilitating ailments including typhoid fever, arthritic-like joint diseases, and severe diarrhea. Death can occur from any of these challenges.

Pot chlorination involves use of a clay pot (7-10 liters capacity) with several dozen holes, 6-8 mm in diameter, drilled in the lower half. The pot is then half filled with gravel (20-40 mm in diameter). A 1:2 mixture of bleaching powder (hypochlorite) and clean sand is placed over the gravel, and then gravel is used to cover the bleach/sand mix and fill the container to the neck. No lid is used. The pot is then lowered into the well for one week. Bacteriological tests could be carried out to assess presence of toxic microbes—if positive readings are found, then the pot chlorination treatment could be repeated. It is estimated that the cost of the pot chlorination system appears nominal compared to the potential community health benefits. The pot may cost around KSh 500 (USD 6.58), and a week's supply of bleaching powder could cost about KSh 10 (USD 0.13). The main technical constraint is the ability to reliably monitor bacteriological quality of the water.

Onset of typhoid, cholera, and dysentery reportedly occur more commonly during the later stages of dry seasons when the people of Kargi are forced to procure water from a dwindling supply of riskier sources (Shivoga, 2002). This suggests, at minimum, that pot chlorination of the younger wells may be most useful at very specific locations and certain times of the year preceding intensive use. Finally, the Kargi community could benefit from extension education that emphasizes linkages among human health, sanitation, and water resource management.

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

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The GL-CRSP Pastoral Risk Management Project (PARIMA) was established in 1997 and conducts research, training, and outreach in an effort to improve welfare of pastoral and agro-pastoral peoples with a focus on northern Kenya and southern Ethiopia. The project is led by Dr. D. Layne Coppock, Utah State University, Email contact: lcoppock@cc.usu.edu.

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GLOBAL LIVESTOCK CRSP

Pastoralism Under Pressure: Tracking System Change in Southern Ethiopia

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While economic development has proven elusive in African pastoral systems, change is pervasive. The Kajiado Maasai, for example, have endured declines in terms of per capita livestock holdings and other aspects of human welfare over the past 50 years. Activity diversification has occurred in Maasailand as the population copes with pressure from human population growth. We surveyed up to 317 Borana households during the late 1990s to see if similar patterns occurred in southern Ethiopia. Once viewed as an example of sustainable pastoralism, the Borana system now confronts numerous challenges. Decline in per capita cattle holdings has spurred household-level diversification to include maize cultivation (emergent agropastoralism) and camel husbandry in some areas. Resource pressure has encouraged annexation of some formerly common-access grazing areas. Strong economic links between pastoral households and local towns, in the form of wage employment or petty trade, however, appear very limited and reflect the general isolation of the Borana pastoralists from development processes. Our findings suggest that patterns of internally induced change due to population pressure in pastoral systems are broadly predictable. Development intervention priorities should reflect system change. A focus on improving risk management by facilitating access of pastoralists to education, encouraging appropriate economic diversification, and assisting in restoration of key ecological resources may be the most appropriate development options for southern Ethiopia at this time. Shifts to increasing reliance on maize production makes these populations more at risk and more likely to require food aid in the future.

Background

Attempts to "develop" African pastoral production systems using western concepts and models have typically failed. Lack of impact from development efforts, however, should not imply that pastoral systems do not change—indeed, change is widespread, although it can often be negative. The Maasai of semi-arid Kajiado District in Kenya are perhaps the most thoroughly studied pastoral group in East Africa. Overall, change for the Kajiado Maasai over the past 50 years can be summarized as follows: (1) Decline in the ratio of cattle to people; (2) decline in the per capita milk supply for human consumption; (3) increased reliance of people on non-pastoral foods such as cereal grains; (4) increased privatization or annexation of natural resources; (5) diversified livestock holdings; and (6) increased poverty for some segments of Maasai society. One factor driving this pattern has been internal pressure from human population growth (Evangelou, 1984; Galaty, 1994; Campbell, 1999).

We have tracked the Borana pastoral system of southern Ethiopia since the 1980s to see if patterns of change resemble those observed for the Kajiado Maasai. Both systems have a traditional focus on cattle husbandry. We expected patterns to be similar, but felt that the Boran are a few decades "behind" the Kajiado Maasai. In other words, phenomena observed among the Kajiado Maasai in the 1960s or 1970s could be observable among the Ethiopian Boran today. We surveyed from 56 to 317 pastoral households across four study sites in southern Ethiopia to investigate whether livestock holdings have changed over time, how herd owners view changes in the pastoral system, and to assess whether substantial diversification of livelihoods away from traditional pastoralism was occurring (Desta, 1999). In some cases we were able to compare our data with findings from several hundred households studied in the same area during the mid- to late-1980s (Assefa, 1990; Coppock, 1994).

Major Findings

Cattle numbers per household exhibited a "boom and bust" pattern over 19 years (1980 to 1999). Cattle births and deaths are the main factors underlying the pattern. A peak of about 85 cattle per household in 1982 was reduced by 35% in the drought of 1983-5 to 55 cattle per household. The population grew slowly back up to about 80 cattle per household by 1991, when another dry period reduced numbers by about 47% (Desta, 1999). The

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Table 1: Trends in the borana pastoral system as perceived by 317 herdowners[1]

	Perceived Trend (Percent Who Agree)		
Feature	Decreasing	Increasing	No Change
Access to grazing land	91	7	2
Milk for people	97	1	2
Milk for calves	97	1	2
Standard of living	55	11	32
Grain in markets	22	76	0
Pastoral grain consumption	1	99	0
Pastoral dairy sales	29	71	0
Human population	0	98	0
Need for cash income	0	99	1
Cattle production	24	74	2
Sheep production	74	24	2
Goat production	59	38	3
Camel production	14	84	2

[1]Some rows may not add to 100%, and this is due to some respondents having "no opinion."

Note: Seventy-five percent of respondents felt that a gradual privatization of key lands due to creation of fodder reserves and cultivation, and increasing restrictions in access to the deep wells for poorer households, was reducing mobility of livestock herds (Desta, 1999).

population then grew slowly once again until 1999, when a third dry period reduced numbers by over 60% (Shibru, 2001). We concluded that high stocking rates help set the stage for each cattle crash, and that crashes tend to be triggered by drier than average rainfall years. This implies that drought and stocking rate interact to cause livestock crashes. This pattern is very similar to the cycle recorded for Maasailand over several decades starting in the 1960s. Other details concerning the Borana cattle population are covered in PARIMA Research Brief 01-02 ("*Cattle Population Dynamics in the Southern Ethiopian Rangelands*").

When we compared empirical household data collected in 1997 with that for 1988, we observed several patterns. First, the number of people per household appeared to increase 36% by 1997. Second, the number of cattle per person decreased by 19% over the same time frame. Third, the population appears to be poorer. The percentage of households ranked as "wealthy" in terms of per capita livestock holdings in 1996-7 was only about one-third of the figure estimated for 1988. Almost 50% of all of our 317 households reported a decline in wealth status (typically livestock per person) in recent times, while only 7% reported an increase in wealth status. Perceptions of how 317 herd owners see their system changing are shown in Table 1. The overall pattern strongly supports the idea that pressure is increasing over time. The availability of grazing land has reportedly declined, as has the quantity of milk for both people and calves. The vast majority of herd owners also thought that their need to sell dairy products (from an insufficient household supply) had increased, that growth in the size of the human population had occurred, and that need for cash income had increased. They felt that more grain was needed to sustain the human population. Opinions regarding production trends for livestock species were mixed, however (Table 1). Production of small ruminants was generally thought to be in decline, but camel production was strongly viewed as being on the increase—this latter point has been verified by comparing empirical household data from the mid-1980s to that from the late 1990s. Despite the periodic and deep reductions in regional cattle numbers per household in recent years (above), survey respondents tended to feel that the overall number of cattle in the region was increasing. Improved cattle health from veterinary interventions was a primary reason given for this view.

Ranked income sources for 56 households are shown in Table 2. Livestock, as the traditional source of income, was the foundation for income, although non-traditional agricultural activities such as sales of dairy products and grain were also commonly mentioned. Non-pastoral or non-agricultural income sources were very rare, however, and these were dominated by things like mining and wage labor. In general, links of pastoralists to town-based economies appear extremely limited in southern Ethiopia. Only a very few of our households had received remittances. Only 2% of respondents had bank accounts.

The most common form of activity diversification away from traditional livestock production involved maize cultivation. We found that 67% of 311 households were routinely cultivating in 1997, but this varied by study site. A higher percentage (74%) of wealthy and middle-class households were cultivating compared to 61% of poorer households. The

average plot size per household was 1.8 hectares. Maize cultivation was reportedly very rare and unsustained in the southern Ethiopian rangelands until the late 1980s (Coppock, 1994).

Only 57 of 317 households (18%) had members with any exposure to formal education, despite that all were located within a 35-km radius of small towns. The overall illiteracy rate (per capita) was 92%. Those few households with links to formal education were positively associated, however, with activity diversification outside of traditional pastoral production (Desta, 1999).

Practical Implications

In general, patterns of change observed among the Ethiopian Boran appear very similar to those among well-documented groups such as the Kajiado Maasai. Human population pressure seems to be an important factor that spurs fundamental change in these pastoral systems. Differences in the extent and types of system change, however, are likely related to local and national variation in other spheres. The Ethiopian Boran appear far more isolated from development processes and external change agents than are the Kajiado Maasai, who reside near the Nairobi metropolis.

In the absence of effective external interventions—at least in the four sites we studied—the Boran appear to be coping with increased resource pressure by planting more maize, herding more camels, and annexing more forage reserves compared to that in years past. In other work it has been estimated that pure pastoralism—where milk and meat form the foundation of the food supply—can reliably support from 2-3 people per square kilometer in this system. The human population in 2003, however, is probably closer to 6-7 people per square kilometer. Livelihood changes therefore must occur for people to continue to survive in these numbers on this landscape. Grain—whether home grown or purchased—is a vital option to support a higher human carrying capacity here because of its high energy content. This may be a situation where internal pressure helps transform the production system from pastoralism to agropastoralism in areas able to support sustainable cultivation.

Maize cultivation is likely pursued because if a crop is successful, a household can reduce the chance they will have to sell animals and buy grain in the marketplace. Maize cultivation has risks, however—there may be more than an 80% chance that a maize crop will fail in the southern Ethiopian rangelands in any given year (Desta, 1999). Camels have recently become a bit more popular with the Boran because, unlike cattle that largely feed on grasses, camels feed on shrubs and trees that are not only increasing in the environment, but also tend to offer green forage for longer periods during dry seasons. The longer lactation period of camels compared to cattle may also be advantageous in terms of reducing temporal variability in household milk yields. Camels have other liabilities, however, compared to cattle. In absolute terms their numbers remain low in southern Ethiopia, they reproduce slowly, and their milk can only yield a very poor quality, waxy butter having limited utility (Coppock, 1994).

As pastoral systems change, development priorities change. For the Ethiopian Boran, a primary emphasis could now be given on how to mitigate the pressures from a growing human population. We believe more development answers lie in the risk management sphere, namely finding appropriate means for small-scale economic diversification, improving access to education, enhancing livestock marketing opportunities, and restoring key ecological resources lost from degradation or human encroachment. Other investigators (Smith et al., 2000, 2001; Little et al., 2001) have noted large differences between northern Kenya and southern Ethiopia in terms of general economic development and degree of activity diversification among pastoralists—Kenya is much more advanced in these respects. Some successes in Kenya may be transferable to southern Ethiopia.

Table 2: Ranked sources of income for 56 pastoral households on the north-central Borana Plateau, 1996-7[1]

	Income Source[2]						
Rank	Livestock	Dairy	Wages	Grain	Gold	Salt	Other
1	43	0	2	2	1	1	5
2	4	13	1	5	6	3	4
3	3	4	3	6	1	2	0
4	0	7	1	2	0	0	0

[1]Failure of some rows to add to 56 indicates "no opinion" or missing data (Desta, 1999).

[2]Where "grain" implies home-grown cereals (largely maize) that was sold. Gold was typically mined from sites to the north, while salt was mined from volcanic craters to the south. "Other" income sources included cattle trading, gum arabic collection, small-scale entrepreneurial activities in towns, etc. (Desta, 1999).

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Food Aid Among East African Pastoralists

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Using household-level panel data collected quarterly between June 2000 and December 2001, we explore the efficacy of food aid targeting among pastoralist households in northern Kenya and southern Ethiopia. We then extend this analysis to explore how food aid impacts private intra-community transfers, so as to establish whether food aid perhaps crowds out private transfers or if it maybe reaches intended beneficiaries indirectly through induced private reallocations even if its direct targeting proves relatively imprecise. Preliminary results indicate that food aid volumes are very modest, on average, contrary to widespread claims of food aid dependency. Food aid is not well targeted by income or wealth and appears to suffer from some inertia. However, food aid flows especially to locations suffering low rainfall levels while private transfers respond to household-specific asset shocks. By itself, food aid does not significantly impact private transfers. Therefore, there is little evidence of food aid either crowding out private transfers or being indirectly targeted effectively.

Background

Food aid in east Africa has received considerable attention in recent years. Ethiopia, now the largest food aid recipient worldwide, received more than US$500 million in food aid flows from the United States alone in 2003. Donors and Ethiopian policymakers worry openly about food aid dependency. In Kenya, highland farmers have protested the inflow of food aid into their country, arguing that it depresses local maize prices. Internationally, a longstanding dispute between the United States and Europe over the possible commercial trade displacement effects of food aid contributed to the collapse of WTO negotiations in Cancun last September. The root of these various problems commonly associated with food aid originate ultimately in targeting errors, through leakage to unintended beneficiaries and the inadvertent exclusion of food insecure peoples (Barrett 2002, Barrett and Maxwell forthcoming).

The ultimate efficacy of targeting in reducing food insecurity and poverty – and in avoiding undesirable side effects such as dependency, producer price disincentive effects or trade displacement – depends not only on the direct distribution of transfers, however, but also on any induced changes in private transfers between households. Anecdotal evidence from northern Kenya (e.g., Aklilu and Wekesa 2001) suggests that social safety nets, in the form of transfers between relatives and neighbors, act as an important coping mechanism for households. Our data confirm this. During the survey period, over 65 percent of northern Kenyan households surveyed report making transfers of money, livestock, or uncooked food. Nearly 30 percent of southern Ethiopian households report similar transfers. Neither figure includes interhousehold loans.

The suitability of food aid and private transfers may depend on the nature of the shocks experienced by households. External transfers into a community are necessary to help weather community-level, covariate shocks, such as drought, human or livestock disease epidemics, or generalized crop failures. By contrast, informal social safety nets within communities are theoretically better suited to addressing household-level, idiosyncratic shocks not experienced broadly throughout the location. Because severe shocks common to all households can overwhelm local informal insurance networks, food aid and other public transfers are typically most effective in response to community-wide shocks. Meanwhile, because local residents typically have better information about household-level shocks than do external agencies, informal, intra-community transfers are generally more effective in addressing idiosyncratic shocks. Therefore, we investigate whether food aid and private transfers differ by the type (household-level versus community-level) of shocks experienced.

We use household-level survey data the PARIMA project collected quarterly, March 2000 – December 2001, during the peak of and recovery from the serious 2000-1 drought, to explore how effectively food aid and private transfers reach poorer households in the arid and semi-arid regions of northern Kenya and southern Ethiopia. These countries also reflect two different targeting methods employed by international agencies. Those operating

in southern Ethiopia target recipient households through a range of traditional methods (e.g., queuing and food-for-work based on principles of self-targeting, indicator targeting based on the gender of the household head or the presence of children in the household, etc.). Meanwhile, in northern Kenya, food aid distribution has switched to community-based targeting, wherein outside agencies eschew household-level targeting, which is decided entirely by the recipient community. These communities have consistently opted for ostensibly uniform distributions, with each household entitled to an identical ration (per person or per household, depending on the community).

Major Preliminary Findings

Our first major finding concerns the extent to which pastoralist households depend on food aid receipts. Contrary to widespread concerns about food aid dependency, we find that although many pastoralist households receive aid, the quantity received comprises only a small portion of total income for most households. In northern Kenya, 89 percent of the households surveyed received food aid. In southern Ethiopia, only 54 percent of households received food aid. This difference plainly reflects the use of community-based targeting in Kenya but not in Ethiopia. Nonetheless, food aid comprised 11 percent or less of income for half the Kenyan households during the drought crisis, and only represented half or more of income for 17 and 21 percent of Kenyan and Ethiopian households, respectively (Figure 1). Only about one-third of southern Ethiopian pastoralist households derived more than one quarter of their income from food aid, as did only 30% of Kenyan pastoralist households. These amounts seem modest indeed among very poor populations experiencing a severe drought.

Not only were Kenyan pastoralist households more likely to receive food aid during and following the 2000-1 drought, they also received more of it than did Ethiopian pastoralists. Daily per capita food aid values were meager in both places, less than $0.03 per person per day, on average, in Kenya and less than half as much in Ethiopia. Consistent with the indicator targeting widely employed in Ethiopia, household demographics also played a major role in food aid receipt patterns. As Figure 2 shows, the value of food aid received per day per capita varies markedly with the age and gender of the household head. In both Ethiopia and Kenya, households with older female heads receive significantly more food aid than those with male or male heads.

Our second major finding concerns the responsiveness of food aid and private transfers to covariate and idiosyncratic shocks. Food aid flows do not respond significantly to either household-level or community shocks to either income or assets. Although there appears to be some inertia in food aid distribution – communities which received aid last quarter have a slightly higher probability of receiving aid this quarter – food aid also flows in response to drought. As the amount of rain received decreases, food aid receipts increase. In other words, during times of drought, households did receive more food aid. A 200 millimeter decrease in rainfall over the quarter results, on average, in each recipient household receiving an estimated $0.01 per person per day additional in food aid. Although food aid offers meager compensation for losses, it at least flows roughly in response to community-level need during drought. Direct food aid distribution is nonetheless poorly targeted at the household level.

Although food aid does not respond to idiosyncratic or covariate shocks faced by households, private intra-community transfers do respond to household-level shocks, albeit still in only very modest quantities. For example, a household-level asset shock equivalent to losing one TLU leads to an estimated $0.25 increase in total private transfers of cash, livestock, maize, milk, and sugar received from other households over the course of three months. Private transfers are nonetheless substantially smaller than food aid receipts, as shown in Figure 3. Male-headed households in Ethiopia tend to give transfers, while female-headed households tend to receive them. In Kenya, all of our stylized households received transfers from other households, reflecting the greater role played in Kenya by remittances from family members who have moved to towns.

Figure 1. Food aid receipts as a share of pastoralist household income, 2000-1 drought

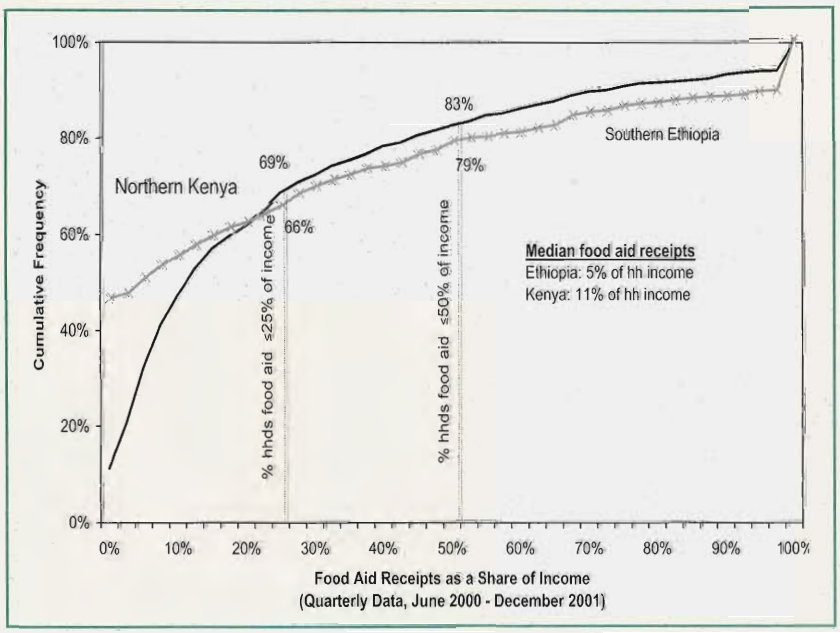


Figure 2. Value of food aid per capita per day by household types for households who received US dollars.

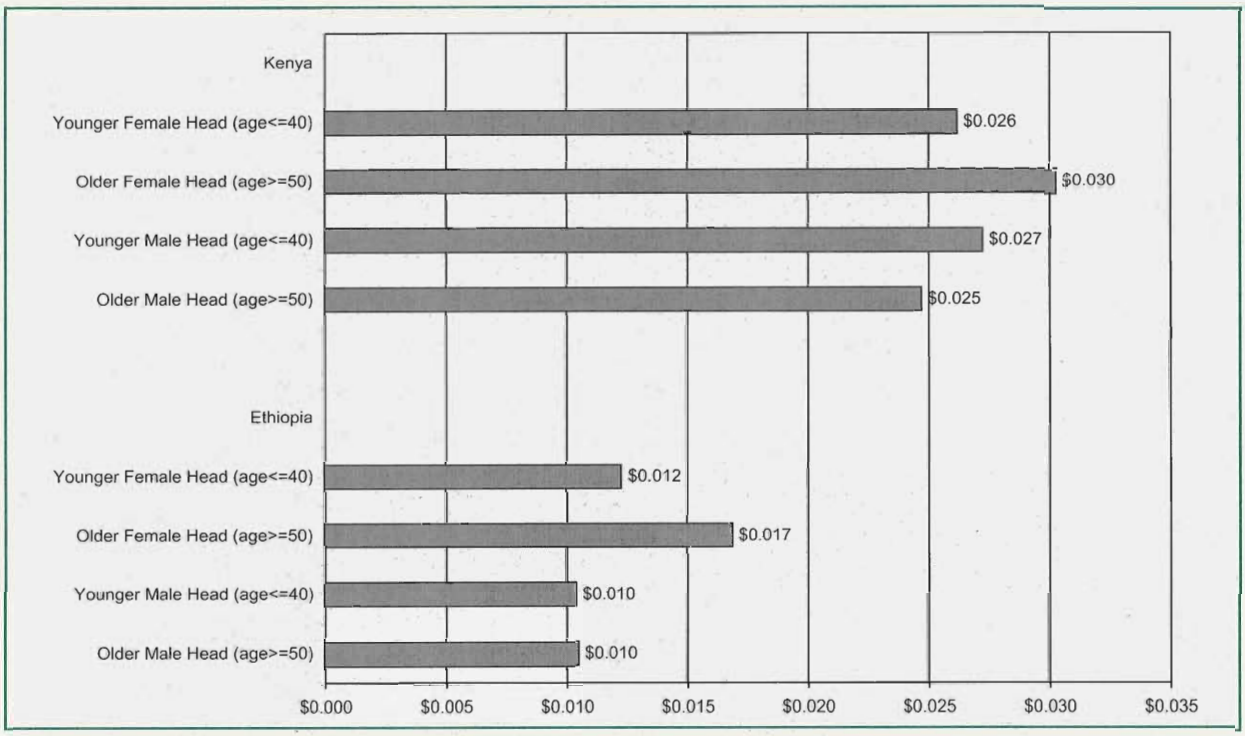
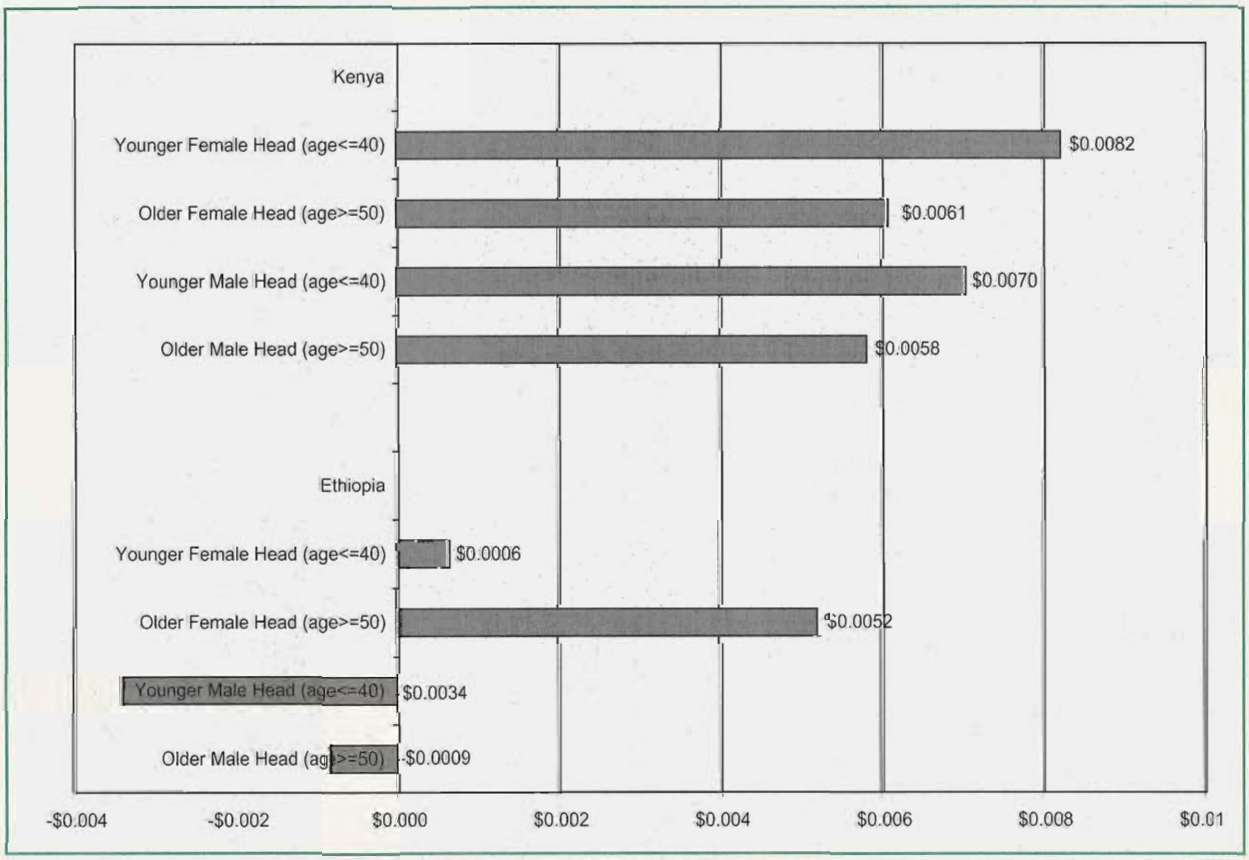


Figure 3. Value of net private transfers per day per capita per household types where net private transfers are inflows minus outflows.



Our third major result concerns the impact of food aid on private transfer patterns. Households' intra-community transfer patterns do not appear impacted by community-level shocks nor by food aid receipts. Food aid, then, does not appear to "crowd out" private transfers. Nor is food aid, in the form of uncooked food, indirectly targeted in the sense that subsequent, private transfers correct the initial household-level targeting errors associated with community-based food aid targeting. So the hypothesis that in the absence of formal targeting by external food aid providers, households endogenously redistribute food aid to the most needy members of a community appears false.

Overall, these results indicate that food aid does not appear to be well targeted to individual households, and is subject to inertia in distribution. Further, food aid flows do not respond to community-wide asset or income shocks, only to rainfall shocks regardless of their impact on pastoralist welfare. The volumes of food aid distributed remain modest for all but a small number of households. Private transfers respond modestly to household-level, idiosyncratic shocks, thereby addressing some of the failure of food aid to reach households and communities in shock. Yet private transfers are even smaller in volume than food aid flows to pastoralist households. In short, there is no effective safety net in place for pastoralists in this region.

Practical Implications

This brief offers the first known survey-based evidence on food aid and private transfers to pastoralist households in the rangelands of east Africa. A solid understanding of how well food aid is targeted according to household need and the shocks they experience, and how households subsequently adjust – or don't adjust – private interhousehold transfers in response to food aid flows, is essential to helping policymakers, donors and international NGOs make best use of limited resources while minimizing the risks of adverse effects associated with dependency, producer price disincentives or trade displacement.

Overall, food aid contributes a relatively minor share of pastoralist households' income. While it is not well targeted to individual households and does not respond appropriately to community-level, covariate asset shocks such as livestock losses, it does not appear to disrupt private transfer systems, although these provide poor households even less insurance against shocks than food aid does. On balance, transfers of any sort, whether from other households or from external agencies providing food aid, appear to play only a modest role in the pastoral regions of northern Kenya and southern Ethiopia, even in the midst and aftermath of a major drought.

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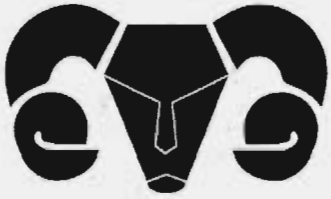

Promotion of Pastoral Development in Kenya: Perspectives from the Kenya Pastoral Parliamentary Group (KPPG)

The Hon. Mr. Ali Wario
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Pastoral Risk Management Project

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The rangelands of Kenya occupy a very large portion of the nation. The livestock-keeping peoples who reside in these areas are disproportionately affected by high rates of poverty and poor access to services and developed infrastructure. Recurrent effects of drought and environmental degradation are also important issues. Despite proclamations made since the 1980s that development must occur in the dry lands, pastoral development policy has essentially been dormant for over 20 years. The Kenya Pastoral Parliamentary Group (KPPG) is a legislative advocacy group comprised of people who are elected Members of the Kenya National Parliament. The KPPG sees great opportunity in the current Constitutional Review process and feels it can now more actively promote the development interests of pastoral people. A re-awakened focus on pastoral policy should highlight needs for improving the access of pastoralists to natural resources, formal education and health care, and strive to eliminate food insecurity and poverty. Cornerstones of such an approach should include renewed efforts to promote minority rights, advocate for pastoral compensation and reparations with respect to past injustices, proclaim the value of the various contributions that pastoral societies make to the nation at-large, and push for local sovereignty over common property resources.

Background

The arid and semi-arid lands (ASALs) of Kenya are rangelands. They are pre-dominantly occupied by pastoral and agro-pastoral groups and cover about 466,000 km2 or 88% of the country. The population is about 5.8 million people. Annual rainfall varies between 125 to 500 mm in arid districts and between 400 to 1250 mm in semi-arid districts. The economic mainstay is livestock production. The ASALs account for 50% of the livestock, 3% of agricultural output, and 7% of commercial output for the nation.

The ASALs are subjected to an increasing frequency of drought, which also contributes to accelerating poverty. An average household may lose large percentages of livestock with each drought. Increased dependency on food aid, insecurity, and poor infrastructure are other major concerns.

The ASALs support over 90% of Kenya's large wildlife species, as most of the national reserves and parks are in the rangelands. The pastoral regions are associated with fragile environments prone to ecological degradation.

Many pastoralists live in poverty. Infant mortality rates are high. Baseline surveys show that absolute poverty is highest in Marsabit District as a percent of the total population (88%) compared with the national average of 47%. Poverty rates for Samburu District (84%), Isiolo District (82%), and Mandera District (68%) tend to be higher than figures for Wajir District (58%), Garissa District (48%), and Laikipia District (46%), but all are unacceptable.

Initiatives to increase investment in the development of Kenya's dry lands started to gain momentum in the mid-1980s following recognition that there was little arable land in the higher potential regions that remained available for agricultural expansion. Since 1986, therefore, the official policy of the government has been to develop the arid and semi-arid land areas. Two key documents that underpinned this stance included: (1) *Session Paper No. 1 (1986) Economic Management for Renewed Growth*, and (2) the *Sixth National Development Plan 1989-93*. Both emphasized the need to implement concrete strategies for change in the ASALs through development of reliable water sources, improvement in livestock marketing, facilitating adoption of appropriate agricultural production techniques, and building capacity for rural communities. The fact is, however, that the implementation of such policies has been almost nil.

The Kenya Pastoral Parliamentary Group and the Constitutional Review

The Kenya Pastoral Parliamentary Group (KPPG) consists of Members of Parliament who have a special interest in the welfare of people who reside in the ASAL districts of Kenya. The KPPG is an organ for national advocacy and lobbying. The KPPG has existed for several, 5-year parliamentary terms and the current membership is around 40.

The Government of Kenya is presently involved in a Constitutional Review that will lead to a number of policy reforms. The process reviews all constitutional and institutional frameworks with an objective of making changes that will assist in the development of the nation. Prominent will be goals to alleviate poverty and promote sustainable livelihoods.

The process is expected to result in new policies and laws that will have critical implications for improved governance. The process offers great opportunity for pastoralists and other marginalized groups in Kenya to articulate their concerns and have their interests embodied in new frameworks.

Pastoral Policy Objectives

One foundation of the KPPG approach is **advocating for community-based property rights** in the pastoral regions. The KPPG believes that in order to give legal recognition to pastoral rights in general, it will also be necessary to formally recognize pastoral communities as legal entities. This entails an increased awareness among policy makers that these pastoral communities already have in place numerous mechanisms for managing natural resources. These mechanisms are founded on rules of conduct that have evolved over long periods of time. New policy needs to recognize the attributes of these systems.

Kenya is a signatory to three covenants that bind her to **guarantee food security** to the citizenry. *Article 25 (I) of the Universal Declaration of Human Rights of 1948 bestows the right to food for everyone. The Convention on the Rights of the Child* commits the state to provide adequate, nutritious foods and clean drinking water. The *African Charter on Human and Peoples Rights* requires the state to assist the family in its physical and moral health and notes the right of the aged and disabled to special protection in keeping with their physical or moral needs. None of these covenants have been translated to national law (in Kenya) as required. The Constitution of Kenya is silent on the critical issue of access to food as a basic right. The KPPG will lobby for adoption of these declarations by the government since the pastoral regions are the most food insecure in the country.

Formal education is a basic human right that is recognized by various international conventions of which Kenya is a signatory. According to a speech by the Minister of Education at a recent conference, it is indicated that "some 1.5 million Kenyan children are not in school due to poverty, inadequate financial resources, and other socio-economic problems, and this figure is likely to increase to 4.4 million this century as school drop-out rates continue to rise." The ASAL districts also record the lowest basic enrollment rates in Kenya, further compounding the problem. Gender disparities in primary and secondary school enrollments are also higher in the pastoral regions of Kenya compared to the national patterns—education of girls is not valued in traditional pastoral societies. Cultural and religious differences have greatly influenced school attendance and enrollments, and combinations of drought and flooding during rainy seasons contribute to the deaths of livestock and subsequent destitution leading to an inability for parents to pay school fees. Insecurity also causes low rates of school enrollment. Students from ASALs suffer from comparatively dismal performance on national standardized examinations. As one outcome of these serious issues, the KPPG joins the recent chorus for free and compulsory education, and this needs to include children of pastoralists. School boarding facilities must be provided and mobile education services need to be developed to better suit the nomadic aspects of pastoral lifestyles.

The Kenyan Constitution, which guarantees the protection and preservation of "fundamental rights" and other basic freedoms for the individual, does not mention **health care** directly. The provision of health services is recognized not only as a basic human right, but also an essential condition for the overall social and economic development of the nation. Baseline surveys conducted by UNICEF in North Eastern Province revealed that, on average, residents must walk hundreds of kilometers one way to reach a health care facility. The KPPG will fight for domestic legislation relating to health provision and strongly proposes the development of mobile clinics for the ASALs to better suit pastoral lifestyles.

The incidence of **poverty** among Kenyans has deepened and an estimated 12.6 million Kenyans across the nation are absolutely poor. Recently, the Government of Kenya has launched the National Poverty Eradication Program (NPEP) which seeks to provide an enabling national policy framework for addressing poverty. The plan has as its major components a charter for social integration that sets out the rights and responsibilities of citizens and communities and envisages major improvements in the supply and accessibility to basic services. The KPPG will lobby for acceptance of the Basic Rights Framework that would pave the way for a greater national consensus on the core basic rights of the citizenry and allow for a leaner and more collaborative targeting of poverty among Kenyans, with a view of giving special consideration for marginalized groups such as pastoralists.

Five Cornerstones for Change

This report has given a grim picture of the pastoral regions in terms of prevailing crisis and the poor legislative track record to shape ASAL development. The question posed here is, however, are there really opportunities for meaningful development in the pastoral lands? The answer is "yes," and this author further qualifies this as a "big yes." Some legal and political cornerstones for change are summarized as follows:

(1) **Constitutional guarantees of minority rights**. Under the Bill of Rights, the Constitution of Kenya should expressly provide for the promotion and protection of minority groups such as pastoralists;

(2) **Compensation and reparations for pastoral people.** Pastoralists have suffered many injustices under successive colonial and post-colonial governments. A special commission should be established to address the losses and damages suffered and seek legal means for community compensation and reparations;

(3) **Special consideration for pastoralists due to historical injustices.** Because of the perverse degree of poverty and under-development in the Kenyan ASALs, the government should be constitutionally bound to give special consideration for pastoral regions today in terms of prioritization of development resources to better bridge large welfare gaps that exist between pastoralists and other citizens of Kenya;

(4) **Formal recognition of pastoralism as an important sector of the national economy.** Pastoral livelihoods have been disregarded by the nation in the past as viable and significant aspects of national life and national economy. This needs to be overcome, in part, through formal, political endorsements or proclamations; and

(5) **Recognition of sovereign rights focused on common property.** As noted above, common property rights refer to the rights of rural communities to access, manage, control, and own natural resources that have been part of customary production systems on lands. These resources have often and inappropriately been regarded as being completely in the public domain. Sovereign rights of pastoralists concerning their common property should be clearly entrenched in the National Constitution.

Further Reading

This report has been edited and condensed from a public presentation now documented in the following publication:

Aboud, A.A., Gebru, G., Desta, S., and D.L. Coppock (eds). 2004. *Pastoralism in Kenya and the Policy Environment: Linking Research, Development Actors, and Decision-Makers. Summary of Proceedings.* Meeting held 8 August, 2003, at the Headquarters of the Kenya Agricultural Research Institute (KARI), Nairobi. Published by the Pastoral Risk Management (PARIMA) Project of the Global Livestock Collaborative Research Support Program (GL-CRSP). Utah State University, Logan, Utah, USA. 32 pp.

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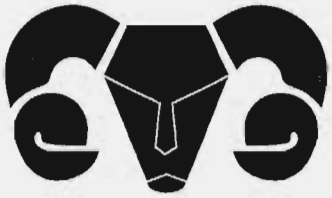

Can Formal Education Enhance Risk Management for Pastoralists? The Case of the Il Chamus of Baringo District, Kenya, 1980-2002

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Pastoral Risk Management Project

Research Brief 04-03-PARIMA August 2004

The impacts of formal education in pastoral communities are not well understood. With few exceptions, little systematic research has been conducted, in part because education is not widespread among herders nor has it always been welcome. The rangelands of northern Kenya are not unusual in this respect and educational levels are much lower there than elsewhere in the country. This research brief addresses the question "can formal education assist pastoralists to better manage risk?" It argues that education should be viewed as a means to supplement pastoralism, rather than--as is commonly perceived--a way to 'exit' from it. By building on a rich data base from two different periods (1980-1981 and 2000-2002) in the Il Chamus area of Kenya, the authors suggest that 'with education' homesteads have more favorable food security and higher incomes than 'without education' units because they receive more remittances, depend less on food aid, have greater cash savings, and have higher food expenditures. However, in terms of livestock management and herd loses, the 'with education' fare as poorly during droughts as 'without education' homesteads. The brief concludes with recommendations on how education can play a positive role in improving pastoral risk management.

Background

This brief builds on homestead[1] studies from 1980-1981 (see Little 1992); quarterly surveys during 2000-2002; and a recent case study (see Lenachuru 2002). Data collected during 2000-2002 was supported by the GL-CRSP's Pastoral Risk Management in East Africa (PARIMA) Project.

The Il Chamus are a Maasai-speaking group located in the Baringo District of north-central Kenya. They were never a wealthy pastoral community even in 1980, but their livestock holdings were especially low in 2000 even when accounting for the 1999 drought (see Table 1). Available grazing lands also have declined due to human population growth and agricultural expansion. Between 1980 and 2000 population in the area almost doubled from 8,782 to 15,592 (or 32 people per square km, Kenya 2001: 144), and available grazing lands declined accordingly. Population and land pressure in the region would have been even worse were it not for the increased numbers of Il Chamus working and living outside of Baringo District, approximately 10 percent of the population in 1999.

Based on this deteriorating livestock and land situation, investment in formal education to acquire employment has become an important strategy. Two local homestead heads expressed the rationale as follows:
"With education one can get a job . . .Salary is more reliable than livestock and one can easily buy/restock his herd with salary/loan (interview, September, 2000)."
"I send children to school with the expectation of them helping us since livestock are no longer reliable. We used to be proud of many animals to support the family, but not now. Only an educated child has a value in the family for he can do many things – supply food, clothes, educate others, etc. (interview, September, 2000)."

Major Findings

Figure 1 shows the extent to which education among the Il Chamus increased during the past two decades[2]. The average number of school children per household was 0.68 in 1980-81 and 2.17 in 2000, while the percentage of household members with at least Grade 7 education rose from 3 to 18 in this period. More importantly, the percentage of household members with 10+ years of education increased more than ten-fold, and those with post-secondary training grew even more than this. Unfortunately, female advancement in education mainly has been limited to primary school levels. Approximately three times as many males as females had any post-primary education in 2000. Declining education rates for females after primary school probably relate to their early marriages and decreased potential for salaried employment in the current labor market (and, thus, an unwillingness for families to invest in their education). Less than 10 percent of Il Chamus with salaried employment who work outside Baringo District are women.

Table 1. Changes in homestead livestock holdings, 1980 - 2000.

Date	1980-81 (n=29)[b]	2000[c] (n=30)
Avg. Cattle	9	4
Avg. Small Stock	55	24
Range of Cattle Holdings	0-33	0-10
Range of Small Stock Holdings	0-216	0-75
% with less than 3 Livestock Units[a]	(4) 14 %	(13) 30 %

Notes:
(a) Livestock unit= 1 head of cattle or 10 small stock (goats and sheep).
(b) Based on data from Little (1981 and 1992).
(c) Based on PARIMA March 2000 round.

How has increased education affected employment and homestead welfare levels? Table 2 shows that 'with education' homesteads are about ten times more likely to have salaried employment, twice as likely to remit income, six times as likely to find employment outside the area, and expend almost three times as much on 'sharing with relatives' as 'without education' homesteads. Many Il Chamus with salaried employment work outside of their home areas and more than 70 percent of these assist their families.

Has increased education and income diversification (i.e., waged employment) allowed households to better manage drought-related risks? 'With education' homesteads earn considerably higher cash incomes and savings, spend more money on food purchases, have better food availability, depend less on food aid, and own more livestock than other homesteads. The vast majority of remittances from salaried employment are used to purchase foods, an option that only was minimally available in 1980-81. Even immediately after the 1999-2000 drought only 23 percent of 'with education' homesteads were using food aid, as opposed to 66 percent of 'without education' units. Mothers in polygamous homesteads recognize the importance of education for economic security and try to insure the education of their own children. One elder indicated that "there seems to be a kind of competition among many wives, each trying to push her children to school. Each one wants to see that her children are going to school among others (interview, August 2000)."

With higher levels of formal education, non-pastoral income (including wage, trading, and cultivation revenues) increased during 1980 to 2002. Pastoral income from livestock sales accounted for 65 percent of income in 1980-81, but only 25 percent in 2000-02. By contrast, the proportion of salaried/waged income more than doubled during the same period. As this paper has suggested, diversification into salaried employment can be an important means of dealing with drought-induced food shortages and livestock loses[3].

Because the Kenyan labor market constricted during the past decade, recent graduates are less successful in finding jobs than previous ones. More than 60 percent of secondary school graduates who are 22 years or younger were without jobs in 2000, but only 30 percent of older graduates were unemployed. In the 1980s even primary school graduates had as good, if not better, employment prospects than recent secondary school graduates. Twenty-eight percent of Il Chamus household heads who completed 'grades 5 to 8' in the 1970s or 1980s had some 'salaried employment' in 2000.

In looking at how 'with' and 'without education' homesteads cope with drought, it is important to distinguish between herd loses and food insecurity. Herds can be severely damaged by drought but food security not excessively jeopardized if there is waged/salaried income to purchase food. In terms of herd management, formal education seems to have little impact. More than 70 percent of livestock wealth was lost in the recent drought, and differences in

Figure 1. Changes in education trends, Ngambo, Kenya, 1980 - 2000.

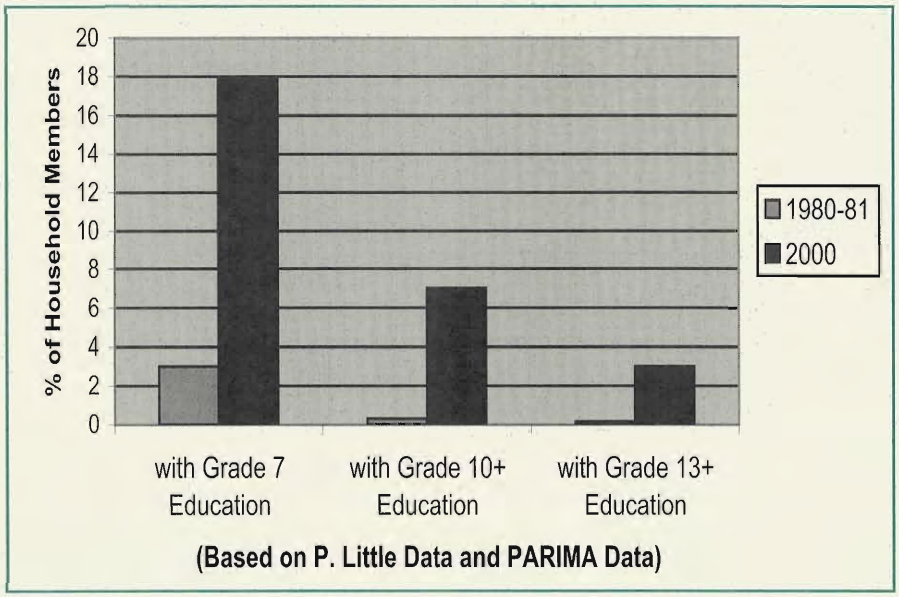

Table 2. Social and economic effects of formal education, 2000.

	Homesteads 'with secondary education'	Homesteads 'without secondary education
% with member in salaried employment	57 %[a]	2 %[a]
% who receive assistance from members 'living away'	78 %[a]	30 %[a]
Annual expenditures assisting relatives (Ksh)	4,441[b]	1,670[b]
Annual food expenditures (Ksh)[c]	16,995[b]	10,230[b]
Total Annual Cash Income (Ksh)[c]	55,593[b]	26,542[b]
% income derived from animal sales	21 %[b]	34 %[b]
% who claim 'good' food availability	70 %[b]	49 %[b]
% who use food aid	23 %[b]	66 %[b]
Average Number of Animals Owned	9.8 cattle, 41 shoats[b]	6.4 cattle, 30 shoats[b]
Number of Animals lost in drought	19.5[b]	12[b]
Losses as % of total cattle owned	67 %[b]	65 %[b]
Annual cash savings[c]	5,634[b]	999[b]

Notes:
(a) Based on the PARIMA Study (30 households).
(b) Based on analysis of Lenachuru/PARIMA data (198 households) by P. Little.
(c) These figures are greatly inflated because they were based on monthly recall after a drought when food expenditures were very high and sharing among relatives was high. The recorded figures were adjusted since they frequently covered more than one year.

loses between 'with' and 'without education' homesteads were minimal (Table 2). In absolute numbers the 'with education' units actually lost considerably more livestock than the other group. In fact, education may actually constrain pastoral production in the area by removing herd labor (children) and then relying on hired herders who can be careless with their animals. Additionally, according to local elders "educated youth" have little respect for customary tenure rules and controls and are strong proponents of land privatization, which can greatly damage range and livestock productivity in communal grazing areas.

Practical Implications

Clearly formal education has positively impacted employment and food security and, thus, reduced risk for some Il Chamus homesteads. Those 'with education' have fared better than others along a range of food security and income indicators. Although the Il Chamus area is unique in several respects, there are practical lessons that can be noted. First, because households 'can buy' their way to food security, formal education (and the resulting employment) can have a very favorable impact on pastoral food security. Second, it is critical to distinguish between the effects of education on income and food security and its impacts on pastoralism. As the paper suggests, education does not necessarily have a positive effect on herd management and can actually have several negative impacts on pastoralism. Finally, under current labor market conditions investments in secondary education do not guarantee salaried employment nor opportunities for further training, as they often did in the past.

For policy makers levels of formal education are so low in pastoral areas of east Africa that investments must be increased just to bring them to minimal levels of functional literacy (around grades 4-5). Special attention also needs to be given to pastoral women, since they lag far behind their male counterparts in education, especially at secondary and post-secondary levels. In areas where mobile pastoralism predominates and dependence on livestock remains very high, investments in education must not jeopardize this critical livelihood. School calendars must adjust to the cyclical nature (both spatially and temporarily) of mobile pastoralism, especially in the peak dry-season periods (January-February), while school location needs to reflect the pattern of key water points and pastures. Livelihood diversification will continue to increase in pastoral areas

and though not a panacea for reducing pastoral risk, formal education can play a role as long as its limitations are acknowledged and it does not come at the expense of pastoral production.

Acknowledgements

Assistance in data entry and analysis was provided by Hussein Mahmoud and Eric Silver, both former graduate students at the University of Kentucky.

Footnotes

[1]The term homestead, which can include members of extended families, is preferable to household in describing domestic units and approximates the local concept of 'enkang' (see Little 1992). 'With education' homesteads are those where at least one member has some secondary school or post-secondary training; and 'without education' homesteads are those that have no members with secondary or post-secondary education.

[2]Because former President Daniel Arap Moi was from Baringo, educational opportunities for local residents grew considerably during the 1980s and 1990s.

[3]It should be noted that the ability to pursue lucrative forms of diversification varies significantly between 'better off' and poor homesteads. For the sake of brevity, this paper has not dealt with the amount of wealth-based variation that exists in Baringo.

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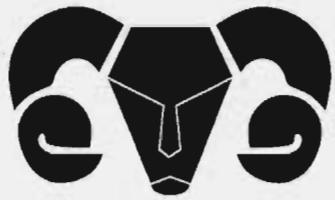

Improving Pastoral Welfare in Ethiopia and the Role of the Pastoral Affairs Standing Committee (PASC)

H.E. Ato Abdulkarim A. Guleid, Member of Parliament and Chairman, Pastoralist Affairs Standing Committee (PASC) and H.E. Ato Kibre Jimmerra Kasa, Member of Parliament and Vice Chairman, PASC

Pastoral Risk Management Project

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Pastoral people have traditionally been ill-served by decision-makers. In recent years the Government of Ethiopia has become more decentralized. Pastoral rights are now protected in the Constitution and pastoral issues are debated in Parliament. The Pastoral Affairs Standing Committee (PASC) of Parliament has been recently formed. The PASC has responsibilities for legislation, governmental oversight, and representation. Decentralization will help improve public service delivery and democratization in Ethiopia. Momentum towards a more comprehensive pastoral development process will be founded on many things. The uniqueness of pastoral systems needs to be better understood by decision makers, including the requirement that pastoralists be opportunistic and mobile. The rights of pastoralists for critical grazing and water resources need to be better appreciated and protected. Pastoral livestock production needs to be better supported by early warning, animal health, and marketing systems. Decision makers need to embrace a greater human focus. Bottom-up processes will help empower the poor. Pastoral development will require creativity and collaboration at local, national, and international levels. One example of international cooperation in West Africa has been to open borders to pastoralists to restore mobility. A similar system should be implemented among member states of the Greater Horn of Africa.

Background

African pastoralists have been ill-served by development policies and actions. In the narrow view of many policy makers, planners, academicians, and researchers, pastoralism has been seen as an out-dated and destructive form of land use. Thanks, however, to emerging work of researchers and others, and thanks to efforts and awareness-raising from pastoralists themselves, the world at-large is now seeing and understanding pastoralism in a more positive light than ever before. However, this does not mean that the way forward for pastoral development is without problems or challenges.

In Ethiopia, the major constraints facing pastoral people include: (1) Lack of access to information; (2) lack of skills afforded by formal education; (3) lack of access to basic public services; (4) increasingly restricted access to critical natural resources (perhaps the single most important challenge); and (5) lack of participation by pastoral communities in the decision-making processes that profoundly affect their lives.

Outdated pastoral policies, however, are still in effect for Ethiopia. Development problems are compounded by drought-related crises. The core problem of drought mitigation is to secure sustainable livelihoods for pastoralists, which means reducing vulnerability by increasing the capacity of communities to cope with crisis. Improved risk management is central to reducing the vulnerability of pastoral people.

The PASC

For the first time in the long history of Ethiopia, through new initiatives and the political will of the current government, the rights of pastoralists are now formally protected by the Constitution. Pastoral problems have been hotly debated in the Federal Parliament. A Pastoralist Affairs Standing Committee (PASC) has been recently established as one of 12 standing committees in the Parliament of the Federal Democratic Republic of Ethiopia (FDRE). The standing committees, each with 13 members, were established by proclamation. The PASC has been born as a result of relentless efforts from pastoralists, intellectuals, and civic society organizations.

The broad mission of the PASC is to promote sustainable pastoral development through partnerships with stakeholders. Responsibilities of the PASC include legislation, oversight, and representation. Here we briefly describe each:

Legislation. The primary role of the PASC in legislation

is to make a critical assessment of issues that require policy decisions and to ensure that these decisions reflect the objective conditions of pastoral communities. Drafts of bills and other legislation are critically reviewed by the PASC prior to presentation to the House for final deliberation.

Oversight. The PASC helps supervise capacity-building activities housed within governmental organizations and others. This includes follow-up on various aspects of governance, infrastructure development, public service delivery, marketing, rural finance, peace making, food security, and early warning systems.

Representation includes advocacy by the PASC. The guiding principles are to promote pastoralist-centered representation that recognizes pastoral skills, attitudes, values, knowledge, and rights concerning participation. The PASC seeks to help establish advisory councils of elders as well as pastoral producer cooperatives and unions. The PASC will foster international cooperation to better deal with cross-border issues that affect pastoralists.

Role of Government Decentralization

Generally, it is agreed that decentralization of government is an essential element in the progress of increasing the profile of pastoralists in the nation. Decentralization can help redistribute resources in favor of the poor, deliver public services more effectively, enhance accountability, and foster democratic participation of local people in decision-making processes. Good governance should be based on decentralization. This will help create an enabling political and legal environment for more equitable economic growth and assist in the mobilization of civil society. There is also a need to aid the efficient development of the private sector to generate jobs and income. Therefore, processes of decentralization and democratization are moving to the pastoral areas. This will help pastoral people become more involved in decisions that affect their lives.

A Way Forward

Below we give some thoughts with respect to how pastoral development could further proceed in Ethiopia.

The first step for decision makers is to thoroughly understand the uniqueness and distinctiveness of pastoral production systems—it's resource requirements and capabilities, the way it promotes the harvest of scarce resources, and the customary basis of it's operations. The main challenge for all is to better understand that the issues facing pastoralists are strategic. Current trends in pastoral systems need to be identified and form the basis for development interventions.

Traditional land rights and resource uses of pastoralists need to be identified and documented. Policies must be worked out for protecting and maintaining the rights of pastoralists to grazing. Pastoral mobility must be maintained. Conflicts among pastoral people must be resolved and henceforth prevented.

An early warning system for pastoral areas needs to be developed along with the means to allow agencies to better respond to crises. A security strategy for food and fodder needs to be developed that allows a timely response to minimize death, suffering, and the undermining of pastoral livelihoods during and after droughts and other disasters.

Disease prevention and treatment mechanisms for livestock must be put in place for timely intervention. Strengthening the scope of livestock marketing systems have to be worked out in such a way that benefits all stakeholders (i.e., the producers, traders, relevant agencies, and exporters). The successful pastoral systems of the future will depend on markets.

There needs to be a shift among decision-makers from "paradigms of things" to "paradigms of people." This process makes "top-down become bottom-up." In addition, the "uniform becomes diverse, the complex becomes more simple, the static becomes dynamic, and the uncontrollable can become a bit more controllable." Moving to a "paradigm of people" corresponds to an empowering process, with a shift of power from national elites to those who are local and poor.

Pastoral development depends on win-win situations forged through cooperation, collaboration, and sharing. This is true at the local, national, and international levels. Let us share with you an example recently observed in West Africa. The Economic Community of West African States (ECOWAS) has created a system whereby pastoralists from one nation can now easily cross the border of another nation for grazing purposes without experiencing legal problems. In the ECOWAS system pastoralists have received a "livestock passport," "international transhumance certificate," and a "handbook of travel." This promotes mobility, an essential attribute of pastoral societies. We believe that neighboring states in the Greater Horn of Africa could embark on a similar plan, perhaps fostered by IGAD (Inter-Governmental Authority on Development).

Concluding Remarks

The Federal Government of Ethiopia understands very well the magnitude, seriousness, and difficulty of challenges facing pastoralists in the country. As a result, the Ministry of Federal Affairs has been mandated, in collaboration with regional state governments and pastoral communities, to help create appropriate institutions with the necessary attributes to meet the pastoral development challenge.

Overall, it can be concluded that the institutional framework has recently been set in place to better support pastoral development in Ethiopia. There is, however, a need for human capacity development and dissemination of information from research and development experiences to help fill knowledge gaps and broaden perceptions. This prominently includes policy makers. Policy makers also need capacity building with partners, whether through formal or informal channels.

Further Reading

This report has been edited and condensed from two public presentations now documented in the following publication:

Gebru, G., Desta, S., and D.L. Coppock (eds). 2004. *Pastoralism in Ethiopia and the Policy Environment: Linking Research, Development Actors, and Decision-Makers. Summary of Proceedings.* Meeting Held 15 August, 2003, at the International Livestock Research Institute (ILRI), Addis Ababa. Published by the Pastoral Risk Management (PARIMA) Project of the Global Livestock Collaborative Research support Program (GL-CRSP). Utah State University, Logan, Utah, USA. 30 pp.

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Design by Susan L. Johnson

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Herd Accumulation: A Pastoral Strategy to Reduce Risk Exposure

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Pastoral Risk Management Project

Research Brief 04-05-PARIMA August 2004

Herd loss is one of the major risk factors in our study sites. As found throughout pastoral areas in Africa, sudden widespread herd loss is an ever present risk facing pastoral producers. We illustrate using data gathered from households in 11 sites in northern Kenya and southern Ethiopia one such incidence of sudden widespread herd loss that occurred in this area in 1999-2000. We investigate the hypothesis that pastoralists adopt a household level herd accumulation strategy during non-crisis periods as a means to reduce exposure to risks associated with herd loss. Herd accumulation pre-crisis increases the prospects that a household will have a viable herd post crisis. The evidence PARIMA has gathered confirms that larger household herd size pre-crisis is positively related to larger expected household herd size post-crisis. This suggests that policy efforts that attempt to limit herd accumulation at the household level but do not address the underlying risk of herd loss may be of questionable wisdom.

Background

Although there are 10 pastoral ethnic groups and two different countries within our study area, one unifying factor confronting the production systems in our eleven sites is the existence of sudden, covariate herd losses that occur with some frequency. As the PARIMA project is focused on issues of pastoral risk management, it is critical that we develop a more nuanced understanding of the role herd accumulation plays at the household level as a form of self insurance, and the implications of this role for pastoral development strategies in pastoral east Africa.

While the tendency of pastoral households to accumulate livestock has been attributed to cultural factors (Herskovits, 1926; Doran, Low, and Kemp 1979) or common property tenure arrangements (Jarvis 1980), there is growing awareness that herd accumulation is a rational self-insurance strategy to follow in an uncertain production environment (Sanford 1983, McPeak and Barrett 2001, McPeak 2003, McPeak forthcoming, Lybbert et al. forthcoming). The results presented below illustrate the simple but powerful logic of this strategy. Assuming that periodic herd die-offs are inevitable in this production environment, and expected post crisis herd size is an increasing function of pre-crisis herd size, herd accumulation is an effective risk management strategy followed by pastoral households.

The PARIMA project has been gathering data since 1998 using a variety of different methodologies to better understand the current effectiveness of traditional pastoral risk management strategies. The household level data used in this brief were gathered as part of an ongoing longitudinal study of over 300 households in northern Kenya and Ethiopia. The results presented in this brief focus on four northern Kenya sites during the crisis period of June 2000 to December 2000[1], and five Ethiopian sites during the crisis period June 1999 to December 2000[2].

Preliminary Results

Herd loss is one of the major risk factors in the pastoral systems. However, there is great variation in how this risk is experienced in the study area during our survey period. Our study showed average household herd loss of as high as 77% in one site in Ethiopia and as low as 21% in one of the northern Kenyan sites. In addition, there were differences in when the losses were suffered. In general, the losses occurred in the Ethiopian sites prior to the losses in the Kenya sites.

The evidence PARIMA has gathered clearly indicates that herd accumulation pre-crisis serves as an effective means of pastoral risk management at the household level in most of our study sites. Consider figures one and two[3]. Figure one simulates regression results obtained by regressing household herd size in December 2000

on household herd size in June 1999 and its square for five Ethiopian sites[4] over the range of herd sizes commonly held in each site. Figure two simulates regression results obtained by regressing household herd size in December 2000 on household herd size in June 2000 and its square for four Kenyan sites[5] over the range of herd sizes commonly held in each site.

For all but one of the sites, post-crisis herd size is an increasing function of pre-crisis herd size over the entire range of pre-crisis herd size. In the one case where this is not true, Dirib Gumbo, only 15% of households had herd sizes that fall in the decreasing zone of the graph[6]. Overall, accumulating animals at the household level is a viable strategy for confronting the risk of herd loss in all sites and over the range of herd sizes for almost our entire sample.

Practical Implications

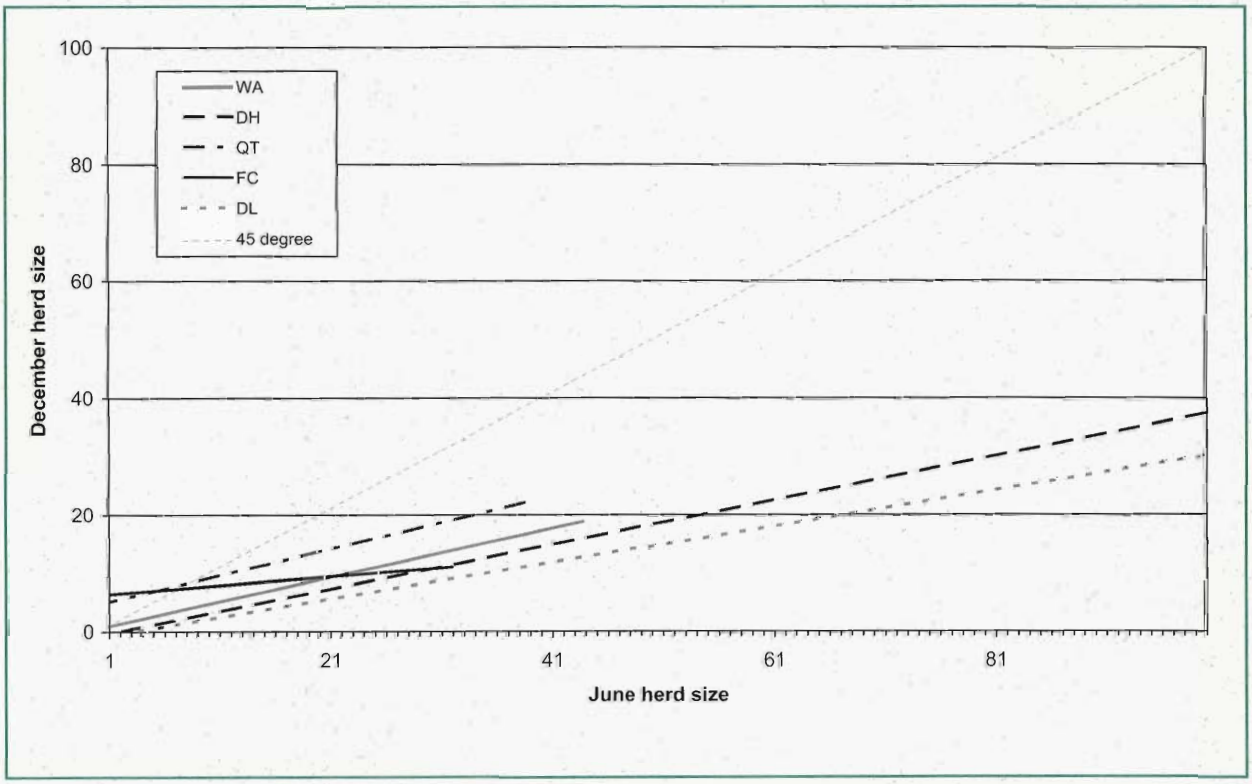
Given weaknesses in the existing financial and marketing systems in the rangelands of northern Kenya and southern Ethiopia, herd accumulation remains the primary and most effective means of risk management for pastoralists. Efforts to stimulate development in these areas must take care not to disrupt pastoralists' capacity to make use of these traditional methods, or else unintended harm may result. For example, any attempt to limit herd accumulation could have negative consequences for household risk exposure if no attempt is made to address the risk that herd accumulation confronts.

Limiting herd accumulation can be sensible if it reduces the risk of sudden herd loss. However, it remains an open question as to the cause of this risk of sudden herd loss. Is sudden covariate herd loss due to climatic conditions? Is loss triggered by livestock diseases? Is aggregate herd size surpassing carrying condition to blame? Is it some complex interaction of these and perhaps other underlying factors? A key topic for further research is to identify why sudden herd loss occurs, so that policy can be expressly designed to help reduce this risk factor[7]. However, until such understanding is developed, it is important to recognize that household herd accumulation is a critical component of household self insurance against such losses and that policy intervention for pastoral areas must be designed in cognizance of this fact.

Footnotes

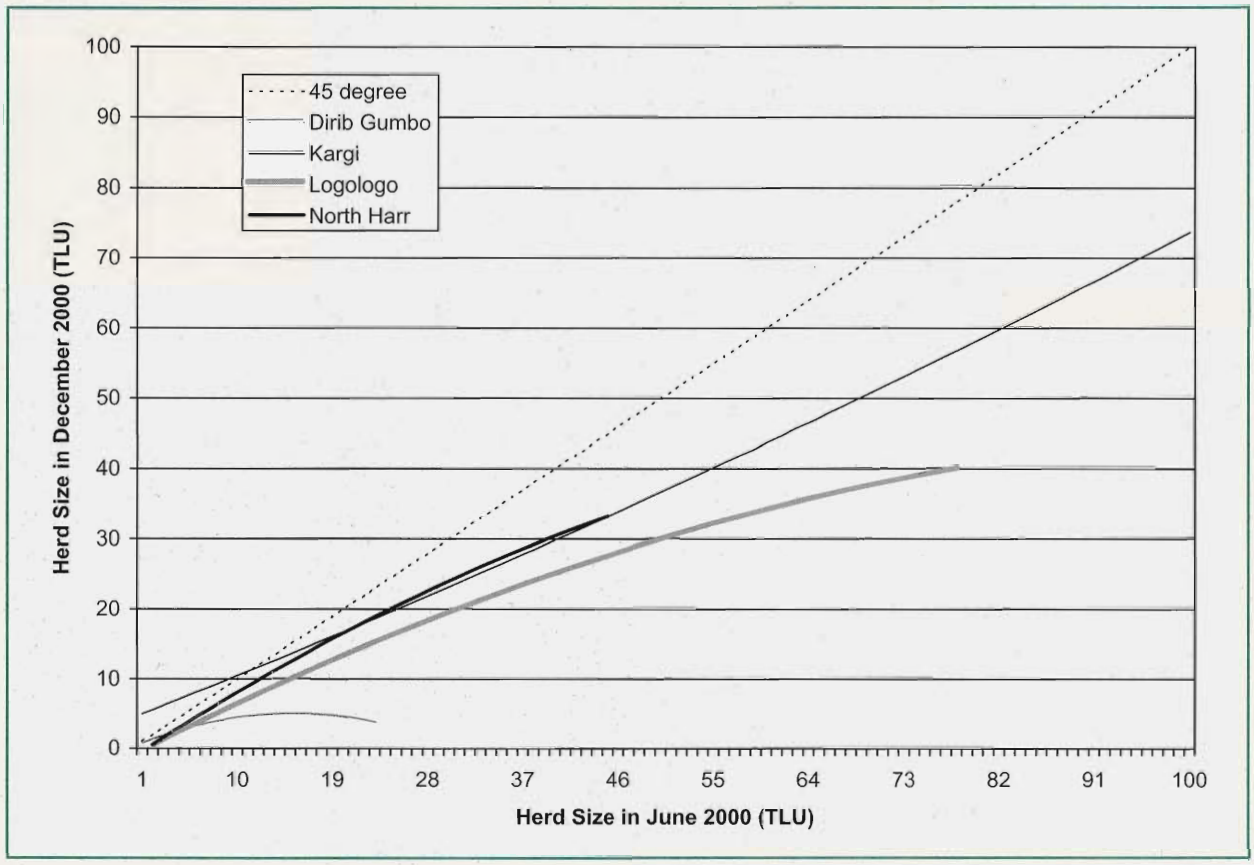
[1]As the focus of this brief is on risk management, we select these four sites since they experienced a crisis during this period that impacted herd size. Paired t-test analysis indicates mean herd size declined significantly in Dirib Gumbo (t=5.43), Kargi (t=3.50), Logologo (t=4.08), and North Horr (t=4.50). The other two Kenya sites of Sugata

Figure 1. Simulation of regression results for herd size post crisis as a function of herd size pre crisis in Ethiopia. Herd size in December 2000 as a function of June 1999 herd size.



WA = Wachille; DH = Didahara; QT = Qorate; FC = Finchawa; DL = Dillo

Figure 2. Simulation of regression results for herd size post crisis as a function of herd size pre crisis in Kenya.



Marmar and Ngambo do not show significant differences in herd size using a paired t-test during this period.

[2]The Ethiopian sites showed major herd loss following June 1999. The paired t-test analysis indicates mean herd size declined significantly in Didahara (t=2.492), Dillo (t=4.36), Finchawa (t=3.55) Qorate (t=2.55), and Wachille (t=11.31).

[3]The axes of figures one and two are measured in TLU terms, and the site specific results are illustrated over the range of the data recorded in the sample. The horizontal axis measures herd size pre-crisis, and the vertical axis represents the expected herd size post-crisis for a given pre-crisis herd size based on the regression results for each site. A 45 degree line is added to provide a standard of comparison for when herd size pre-crisis is equal to herd size post crisis, so that the distance of the simulation line to the 45 degree line illustrates the size of the loss in TLU terms for a given pre-crisis herd size for each site.

[4]Dillo experienced an average loss of 74% over this period, and the R^2 for the regression =0.86. Qorate experienced the lowest herd loss with an average of 34%, and the R^2 for the regression =0.39. Didahara experienced an average 77% loss over this period, and the R^2 for the regression =0.46. Wachile experienced an average 59% loss over this period, and the R^2 for the regression =0.64. Finchawa experienced an average loss of 50%, and the R^2 for the regression= 0.08.

[5]Dirib Gumbo experienced an average 71% loss over this period, and the R^2 for the regression =0.21. Kargi experienced an average 21% loss over this period, and the R^2 for the regression =0.95. Logologo experienced an average 38% loss over this period, and the R^2 for the regression =0.80. North Horr experienced an average 22% loss over this period, and the R^2 for the regression =0.80.

[6]We would suggest that mobility was limited in Dirib Gumbo due to the location of the site on the shoulder of Marsabit Mountain and the tensions between the Boran community of Dirib Gumbo and the surrounding communities during this period.

[7]Evidence presented in Lybbert et al. (forthcoming) and McPeak (forthcoming) using data gathered in this study area suggests that aggregate herd size alone does not significantly influence change in household herd size.

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Design by Susan L. Johnson

GLOBAL LIVESTOCK CRSP

Constraints Limiting Marketed Livestock Offtake Rates Among Pastoralists

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Marketed livestock offtake rates are commonly low among pastoralists in the arid and semi-arid lands of east Africa. Many donors and policymakers have therefore emphasized the importance of interventions to directly address constraints that limit offtake so as to stimulate greater use of markets as a means both to increase incomes and wealth and to improve pastoralists' capacity to manage regular climatic shocks. Yet few of the hypothesized causes of limited marketed offtake have been tested explicitly. Using detailed household data collected every three months in southern Ethiopia and northern Kenya, we are able to identify which hypotheses seem credible for explaining limited marketed offtake. We find that lack of information, cash transaction costs to market participation and limited access to financial savings instruments do not appear to limit livestock marketing. The main constraint on livestock marketing appears to be the limited attractiveness of alternative, non-livestock investments in the study region. In summary, we find scant empirical support for many of the claims commonly made in current discussions of how best to stimulate livestock marketing offtake among pastoralist in this region. The best strategy appears to be generalized support for viable pastoralism.

Background

Pastoralists in east Africa's arid and semi-arid lands (ASAL) regularly confront climatic shocks that cause massive herd die-offs and loss of scarce wealth. Yet marketed livestock offtake rates are commonly low among east African pastoralists. Stimulating marketed offtake by pastoralists, especially in times of stress, in order to convert even a modest share of mortality losses into sales, could avert widespread, acute human suffering and potentially accelerate herd recapitalization once range conditions recover.

The literature is rife with hypotheses for pastoralists' low average marketed livestock off-take rates, including structural constraints ranging from a lack of viable investment alternatives to livestock, high costs and risks of marketing, and quarantine and border closure, as well as social constraints related to livestock's role in local marriage and exchange networks. Using quarterly repeated household-level observations, 2000-2002, from 330 households across eleven sites in northern Kenya and southern Ethiopia, we explore various hypotheses of the low marketed offtake rate puzzle so as to establish where policy or project interventions might be able to stimulate increased livestock offtake by pastoralists, with the intent of identifying feasible interventions that might induce conversion of mortality losses into sales proceeds during drought.

Major Findings

Almost all sample households participate in livestock markets, albeit often in relatively small volumes and at varying rates over time. More than nine out of ten households in our survey sample used livestock markets during the two year survey period. Market participation rates were slightly higher in northern Kenya than in southern Ethiopia and declined steadily after the peak of the drought in June 2000.

The most active household participants in livestock markets own greater numbers of livestock. Households that neither sold nor bought animals own an average of 10.8 tropical livestock units (TLUs), while the households participating in markets most frequently average holdings of over 40 TLUs.

Though ASAL regions are net exporters of animals, net sales volumes are relatively low per household, limiting regional integration into broader national and international trade patterns. Eighty percent of households participated in livestock markets as net sellers, while only 8 percent purchased more animals than they sold (and 12 percent had neither net sales nor net purchases). Quantities traded tend to be small. In no three month period were average net sales greater than 1 TLU for those selling animals. This is consistent with the hypothesis that livestock sales, especially of small ruminants (i.e., goats and sheep), are driven largely by households' immediate cash needs for school fees, medical care, social events, etc.,

Table 1. Percent of households marketing livestock.

% HHs Marketing Livestock In Quarter Ending ...	Jun-00	Sep-00	Dec-00	Mar-01	Jun-01	Sep-01	Dec-01	Mar-02	Jun-02	HHs Marketing Livestock Over 2 Yrs
Dirib Gombo	68%	42%	21%	19%	10%	26%	29%	19%	0%	97%
Kargi	70%	37%	40%	20%	47%	60%	28%	40%	33%	97%
Logo Logo	43%	47%	25%	37%	30%	13%	37%	7%	7%	87%
Ngambo	43%	40%	41%	43%	30%	13%	6%	6%	3%	87%
North Horr	53%	50%	54%	27%	67%	41%	45%	24%	17%	94%
Suguta Marmar	60%	40%	30%	40%	13%	33%	23%	47%	7%	90%
Kenya Weighted Avg	56%	43%	35%	31%	33%	31%	28%	24%	11%	92%
Dida Hara	57%	37%	23%	20%	23%	27%	39%	30%	37%	90%
Dillo	43%	33%	20%	23%	17%	17%	33%	33%	30%	87%
Finchawa	58%	48%	73%	45%	48%	32%	45%	10%	7%	100%
Qorate	13%	23%	0%	20%	20%	0%	23%	3%	33%	63%
Wachille	30%	37%	20%	43%	20%	20%	32%	33%	23%	93%
Ethiopia Weighted Avg	40%	36%	27%	30%	26%	19%	34%	22%	26%	87%

although we cannot test this hypothesis explicitly in these data. If that interpretation proves correct, then there are limited immediate gains to be reaped by ASAL pastoralists from generalized stimulus to regional and international livestock markets because those households are not heavy net sellers of animals and they tend not to sell animals to invest in other enterprises.

Markets are not commonly used for restocking by sample households. Partly this is attributable to insufficient cash liquidity, and partly to a dearth of breeding stock in livestock markets, as more than two-thirds of live animal transactions in Marsabit and Moyale, 1997-2000, were males (Barrett et al. 2003). Purchases account for less than ten percent of net recruitment into herds. These rates vary markedly over time, however, peaking at 10-23 % of additions to cattle herds in the immediate aftermath of the 2000 drought, then falling to only 1-6% of net recruitment by late 2001 and 2002. Poorer households rely more heavily on market purchases for restocking, as they do not have sufficient herds to reconstitute a herd through breeding (Little et al., 2003). In contrast, wealthier households rely almost exclusively on natural reproduction, often purchasing livestock to diversify risk by investing in alternate types or species.

Several oft-heard hypothesized explanations for low marketed offtake rates do not find support in our data. A lack of price and climate information or forecasts does not appear to limit pastoralist livestock marketing (Luseno et al. 2003). On average, pastoralist households received livestock price information from two sources, primarily through traders. Although few respondents go to market themselves to observe transactions first-hand in order to collect price information, informal information networks generate and distribute reliable, timely information about livestock market conditions. Sample households check on livestock prices frequently. 45% of our Kenyan sample checked on market prices at least every few days, while 80% in Kenya and 68% in Ethiopia checked their primary source of livestock price information at least every few weeks. In short, pastoralists in our study region seem to have good enough access to climate and price information through existing channels that lack of information does not significantly limit marketed offtake.

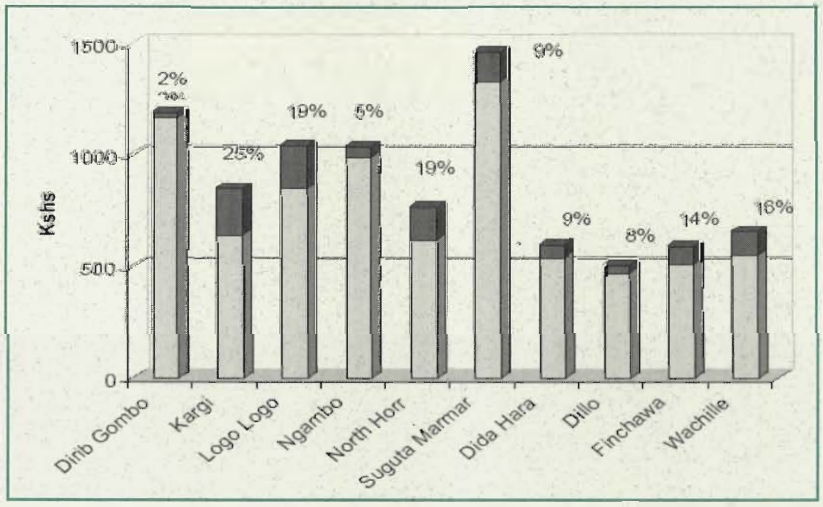
Similarly, transaction costs to market participation do not seem to pose a serious obstacle to sample households' marketing. 67 percent of Kenyan market participants and 79 percent of Ethiopian sample households incur cash costs in livestock transactions, though the percentage of those incurring fees varies greatly according to site. In sites close to large markets, few respondents reported incurring cash marketing costs, while in more remote and pastoral sites, the trek to town more likely involves out-of-pocket expenditures on transportation, lodging, and food.

Sample households' cash transaction costs in livestock marketing are nonetheless relatively low. For small ruminants, marketing costs ranged from two percent in areas close to major towns, to 25 percent in more remote areas (Figure1). For larger species (i.e., camels, cattle), sample households' cash marketing costs averaged less than 10 percent of the sale price in every site.

This informal impression that cash marketing costs do not pose a big impediment to livestock marketing appears borne out by econometric analysis, as marketing costs have no statistically significant effect on either market participation or net livestock sales volume (Osterloh et al. 2004).

It likewise does not appear true that insufficient access to financial institutions in which one might safely keep livestock sales proceeds constrains pastoralists' livestock marketing. Those sample households that held bank accounts were actually slightly less likely to sell animals than those without

Figure 1. Cashing marketing costs per animal as a percent of prices: Goats and Sheep.



bank accounts, reinforcing the hypothesis that livestock sales are largely in response to immediate cash needs, which bank account holders can meet through financial savings rather than liquidation of livestock.

So what does explain low marketed offtake rates among ASAL pastoralists? One fundamental reason is a dearth of other, more attractive investment opportunities. Financial savings are commonly whittled away by banking fees, by loss of share value in locally owned microfinance institutions, or by claims from family and neighbors. And nonpastoral businesses are themselves very risky enterprises. Although pastoralists' expected herd mortality rates are increasing in their ex ante herd size, keeping a big herd nonetheless remains the best investment available in the ASAL today (Lybbert et al. forthcoming, McPeak forthcoming).

The complex property rights that surround livestock likewise seem to reduce sample households' net livestock sales (Osterloh et al. 2004). In the study region, animals are often given or loaned to others in times of need. While the exact arrangements of gifts and loans vary subtly across ethnic groups and clans and over time, perhaps the most common arrangements give the borrower rights to the milk and any offspring born to the borrowed animal(s), while ownership claims over the loaned animal(s) remain with the lender. As a consequence, traditional livestock loaning and gifting arrangements appear to dampen sample households' livestock marketing. The complex property rights regimes that underpin social safety nets in the region thus constrain livestock marketing, but also allow redistribution of animals among households through a non-market mechanism.

Insecurity and the resulting strength of ethnic ties within livestock trader networks likewise seem to impede marketing. Livestock have long been subject to raids from other ethnic groups, and other clans within ethnic groups. The threat of raids poses big risks to livestock traders. To manage the risk of transporting large amounts of cash across long distances from Northern Kenya to Nairobi and vice versa, traders frequently use informal 'money services' to allow cash from Nairobi sales to be received in Northern Kenya and place partners in the Nairobi market, where they better enforce payments from large meat wholesalers (Mahmoud, 2003). Greater than 95 percent of these partnerships are among members of the same ethnic group.

Detailed transactions data likewise reveal that quarantines are a significant source of price risk and that they reduce expected livestock prices received by pastoralists (Barrett et al., 2003). Quarantine erects barriers to trade by impeding commerce and thinning markets in pastoral regions. These effects not only exacerbate risk but also cause substantial revenue losses for herders. Though the effects of quarantine upon livestock prices at terminal markets in Nairobi are negligible, Barrett et al. (2003) find significant negative effects on the prices received and the price variability faced by pastoralists. Pastoralist producers absorb the price shock created by quarantines, simultaneously insulating both Nairobi consumers and protecting highland ranchers. As these subpopulations are much wealthier than pastoralists, quarantines appear to be a distributionally regressive means of animal disease control, wherein the poor pay the costs of benefits captured largely by wealthier citizens.

Practical Implications

Pastoralists in northern Kenya and southern Ethiopia participate actively in livestock markets. But the volumes transacted are small, limiting the possibility of any significant near term impact due to stimulus to broader regional and international marketing opportunities. Market transactions are almost exclusively sales, primarily of goats and sheep, for the most part, it seems, to meet household's immediate cash expenditure needs. There is no strong price response, apparently because prices move largely with the net present value of animals, as determined by prevailing health and range conditions, and because pastoralists balance long-term herd-building objectives with short-term consumption smoothing objectives when deciding whether and what to sell. Bank accounts earning negative returns are poor substitutes for livestock in accumulating wealth, cash marketing costs incurred by pastoralist households are surprisingly modest, and information on climate and prices does not significantly limit pastoralist market participation or sales volumes.

Overall, the strongest correlate of livestock marketing is

herd size, suggesting that preserving or restoring the viability of large herds is the single most important factor in stimulating livestock marketing expansion in the arid and semi-arid lands of northern Kenya and southern Ethiopia. In sum, we find scant empirical support for many of the claims commonly made in current discussions of how best to stimulate livestock marketing off-take among pastoralist in this region. The best strategy appears to be generalized support for viable pastoralism.

Interventions probably make a greater difference at the level of livestock traders, for whom transport costs and physical insecurity pose problems more than for individual pastoralists. Quarantines and other impediments to trade in livestock clearly reduce the number of traders present in markets, reducing aggregate demand and thereby lowering prices and increasing the price risk faced by herders seeking to sell animals. Better control of security and improved transportation and market infrastructure would benefit traders and general market conditions in northern Kenya, as would curtailment of the use of outdated quarantine measures for animal disease control.

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Design by Susan L. Johnson

GLOBAL LIVESTOCK CRSP

Pastoral Risk Management in Southern Ethiopia: Observations from Pilot Projects based on Participatory Community Assessments

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The Borana pastoral system has come under increasing pressure as human populations grow and per capita availability of resources declines. Livestock exhibit large, periodic die-offs that threaten wealth accumulation and food security. Several types of interventions may improve risk management here. For example, there may be opportunity for some pastoralists to diversify their livelihoods. Here we report on a community-based process involving pilot projects begun since 2000. We have embraced Participatory Rural Appraisal (PRA) and Action Research (AR) as tools for investigation and empowerment of local people. Full PRAs were conducted for semi-settled communities, located near towns, to identify priority needs and self-help capabilities. Communities selected interventions for implementation in partnership with local development agents as part of Community Action Plans (CAPs). Preliminary observations suggest that these people see income diversification as a major issue. To this end they have a high interest in non-formal education, micro-savings and credit associations, and micro-enterprise development. Newly formed women's groups have taken the lead in adopting innovations. Our experience confirms that risk-management interventions are in demand here, and that the people are dedicated and capable of novel achievements. Pastoralists also exhibit much enthusiasm when allowed to lead their own development initiatives.

Background

The Borana pastoral system—traditionally based on cattle husbandry for wealth storage and milk production—has been noted in the past as a good example of sustainable pastoralism in east Africa. However, similar to other African pastoral peoples, the Boran have come under increasing pressure as the human population grows and availability of natural resources declines. Drought, massive livestock losses, and poorly functioning markets create crises. People like the Boran are under increasing pressure to survive.

There are several options that might better manage risk. One, especially for pastoralists near towns, is small-scale income diversification. Here we describe our experiences dealing with efforts to enhance income diversification for semi-settled pastoralists. First we describe our tools and techniques.

Participatory methods

Participatory Rural Appraisal (PRA) and Action Research (AR) are two of many approaches whereby control over a project is shared among researchers, development agents, and community members. The PRA model involves partnerships for problem diagnosis and implementation of solutions. The AR model is similar, but in this case researchers assist communities and development agents with rapid assessments of constraints that occur when interventions are implemented. Corrective actions are prescribed. In adopting PRA and AR models, researchers and development agents relinquish much of the power they otherwise have over communities in these settings. By taking the lead in problem identification, communities therefore help set the agenda. One drawback of PRA and AR models is that traditional aspects of research process become less dominant. One advantage, however, is that communities and local partners are better empowered. In this case we feel the trade-off is an easy one to make.

A PRA starts with a comprehensive analysis of the root causes of priority problems, as well as development opportunities that a community faces. Properly done, this can take a week or more. The PRA approach puts emphasis on community responsibility to make decisions regarding sustainable development. The major output of a PRA is an implementation strategy called a Community Action Plan (CAP). Proper use of PRA or AR remains uncommon in east Africa, either among researchers or development agents.

The PARIMA project serves this process as a facilitator, policy liaison, and monitoring partner. The main

objective, overall, is discovery of "what problem solutions work" and general capacity building for all participants. The PARIMA project trains development agents from NGOs and GOs in PRA methods, and trainees then engage communities to conduct PRAs. The CAPs are submitted to an Outreach Review Panel (ORP) for funding consideration. The ORP consists of 10 members (Kenyans and Ethiopians) who are well-experienced in pastoral development. Proposal evaluation is based on 10 criteria. Funds to implement CAPs come from the USAID Mission to Ethiopia.

Preliminary Findings

A number of pilot projects of various types have been implemented on the Borana Plateau over the past four years. Here we focus on two that were started at Dida Hara. The residents of Dida Hara number about 10,000. They are typical of semi-settled pastoralists. Illiteracy is high (>90%) and there was a heavy reliance on food relief when the PRA was conducted. The PRA at Dida Hara was conducted in 2000. It involved hundreds of community members and a couple dozen PRA trainees.

The priority problems at Dida Hara—in order of importance in the PRA—were: (1) Lack of food; (2) lack of water; (3) lack of access to formal education; (4) poor human health; (5) poor livestock health; and (6) lack of marketing and economic diversification. The root cause of most of these problems was seen as the low level of livelihood diversification, both at household and community levels. The possible solutions in the PRA included: (1) Improved agronomic practices; (2) organization of livestock marketing cooperatives; (3) establishment of savings and credit institutions; and (4) promotion of alternative income-generation activities. Two CAPs were created. They ultimately focused on non-formal education and savings and credit options to start to deal with the root problem. These were chosen because they were viewed as the most achievable within a short period of time, and were also most likely to be sustainable.

A local NGO called Action For Development (AFD) assisted in preparation of CAPs. The savings and credit project involves 175 pastoralists, of whom 58% are women. The local office of the Oromia Cooperative Promotion Bureau (OCPB), the Oromia Agricultural Development Bureau (OADB), and others became part of the effort.

Formation of savings and credit groups started in 2001 with creation of primary groups having five to seven people. An average of five primary groups then formed secondary groups having 35 to 49 members. Group members started periodic savings based on bylaws regarding amount and frequency. Emphasis was put on encouraging members on the need to mobilize local resources and develop a savings culture. Group members had to mobilize sufficient savings before starting a program of loan extension, as a savings-led approach has been pursued.

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

During the first year a total savings of Birr 24,688 (or USD 3,100) was achieved across the 175 members. The approach of AFD has mechanisms to enhance performance. These focus on peer pressure. Loan recipients were selected based on criteria such as credit worthiness, ability to engage in the business of their choice, and possession of savings amounting to at least 10% of the borrowed amount. The loan procedure adopted involves a loan application to the applicant's primary savings and credit group and preliminary appraisal of the application by the primary group. If the review is positive, the application is forwarded to a secondary group for further debate. Disbursement of a loan will occur only if the secondary group also approves the application. The loan ceiling is determined by the availability of resources, the amount of savings, and the type of project.

The second pilot project deals with non-formal education (NFE) begun in 2001. The project is an intervention aimed at creating an enabling environment for adults, school-age children, and dropouts to have access to basic education through establishment of community education centers. There was only one formal primary school (grades 1–4) with three teachers in the 2000/01 academic year in the vicinity of Dida Hara. School enrollment was only about 250 pupils from a potential population well exceeding 10,000.

The NFE project was designed to provide an organized,

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

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

To rapidly build capacity to deal with savings, credit, and micro-enterprise development, PARIMA has facilitated training and tours for participants. This includes training courses for the illiterate offered by the Fura Institute of Development Studies (FIDS). Tours for Ethiopians to visit successful women's groups in northern Kenya have also been arranged, and as a consequence many women's groups have been created in southern Ethiopia in the past two years. Kenyan female mentors visit Dida Hara and other Ethiopian sites each year to provide expert advice and boost morale.

Practical Implications

The overall goal of PARIMA's activity is to help promote sustainable approaches for risk-management intervention. Perhaps the greatest lesson we have learned so far is that a true participatory approach can unleash a tremendous amount of energy and enthusiasm for positive change, even in a pastoral setting. This is especially apparent for newly formed women's groups. We have also seen that, with appropriate technical oversight and training, people having little formal education appear capable of implementing activities involved with micro-finance and income diversification. We have also witnessed the great effectiveness of pastoralist-to-pastoralist extension methods that confer rapid transfer of knowledge and skills.

Further Reading

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GLOBAL LIVESTOCK CRSP

Resource Conflict in the Rangelands: Evidence from Northern Kenya and Southern Ethiopia

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Pastoral Risk Management Project

Research Brief 04-08-PARIMA August 2004

Household-level survey evidence indicates that conflict over land and water among pastoralists in northern Kenya and southern Ethiopia is relatively rare. Resource conflict in this region appears to be associated more with the rise of nontraditional land uses, especially crop cultivation in streambeds and valley bottoms traditionally used for grazing and watering herds, than with any growth in herd sizes associated with livestock cycles or growing pastoralist populations. Traditional pastoral communities tend to have fewer resource-related conflicts than communities experiencing a rise in crop cultivation. And the incidence of resource conflict is unrelated to herd size. The traditional pastoral system appears more capable of mitigating resource related conflicts and of resolving them when they do occur. Such conflicts appear to be more frequent and less easily resolved where land use patterns are shifting away from traditional extensive grazing systems towards more diverse land use systems incorporating cultivation as well as grazing. Policies aimed at conflict management should focus on building effective institutional arrangements in such transition areas without undermining indigenous institutions that are crucial to the peaceful utilization of scarce rangeland resources in traditional pastoralist zones.

Background

Changing natural resources patterns in the east African rangelands, perhaps especially the rise of crop cultivation and demographic pressures that increase stocking rates per square kilometer, affect the evolution of the pastoralist systems of the Horn of Africa. Coupled with increasing reports of violent conflicts associated with political struggles and the introduction of semi-automatic weapons into traditional cattle raiding, concern about resource-based conflict has grown in recent years. Yet perhaps because of the emphasis in the media and in policymaking circles on a larger scale, more violent conflicts between ethnic groups, relatively little is known about how individual households respond to the growing challenges of resource competition and potential conflicts in the face of changing land use patterns. To what extent are pastoralists experiencing conflicts related to increasing competition for land and water? And do traditional institutions retain capacity to resolve resource disputes?

This brief explores these important, inter-related questions using survey data the PARIMA project collected in 2002 from 160 households in six sites representing different land use systems and market access: Finchawa, Dida Hara and Dillo in Ethiopia, and Dirib Gumbo, Suguta Marmar and N'gambo in Kenya. Of these, Dillo and Dida Hara have negligible crop cultivation and Suguta Marmar has a modest amount, while Dirib Gumbo, Finchawa and N'gambo have far more diversified land use patterns and better market access.

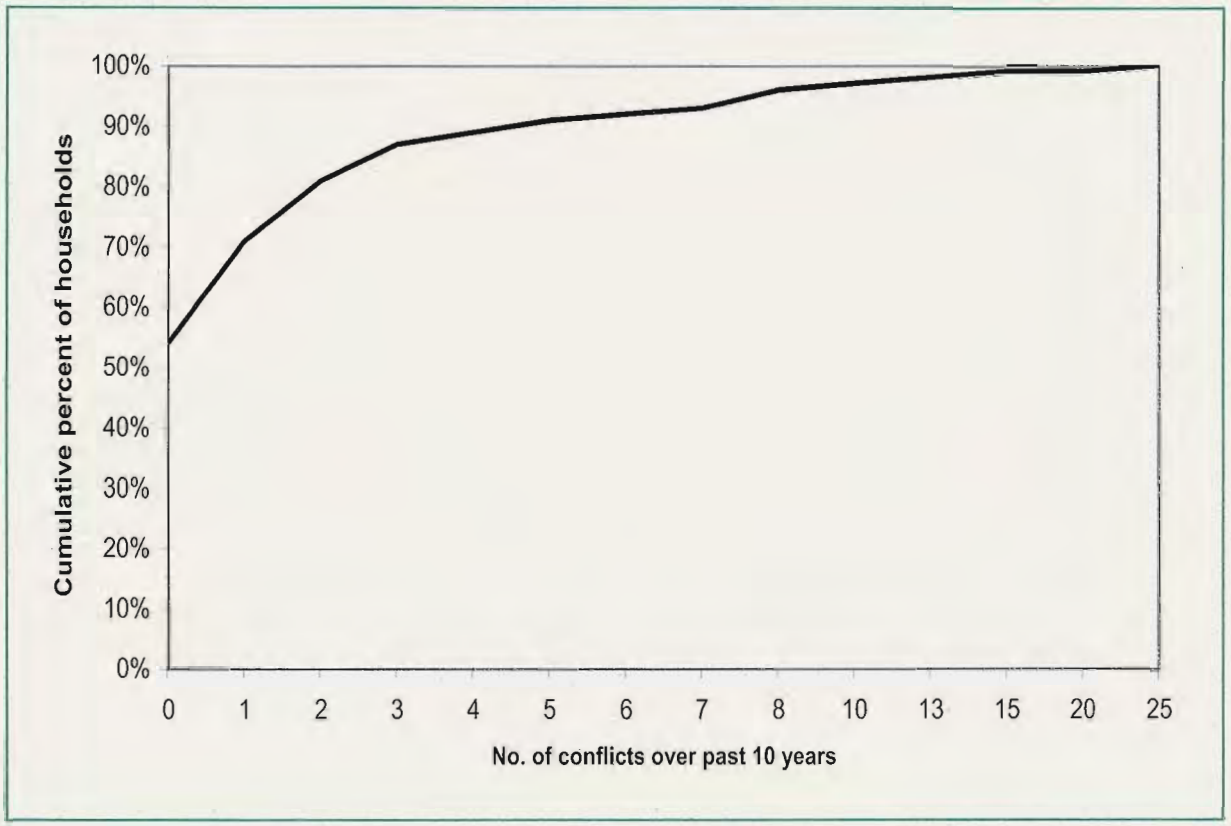
Resource competition resulting from increased human and animal populations and the resulting changes in land use patterns can lead to more conflict over the use of scarce rangeland resources like water and pasture. This may be especially true as non-traditional land use patterns – such as rainfed crop cultivation – emerge, uses that are not governed by established community norms and dispute resolution mechanisms. Strategies to manage such conflicts may require a different approach than is customary among migratory pastoralists.

Major Findings

The survey asked households about inter-household conflicts over land or water resources for herding and cultivation activities during the previous ten years. Households reported fewer conflicts than many observers might anticipate after reading regular stories of raids and counter-raids in the Kenyan media, and 55% of all the households reported to have never experienced any natural resource conflict during the preceding ten year period. More than 85% experienced four or fewer conflicts over land or water in the past decade.

However, further disaggregation of conflict occurrence by source and across study sites reveals that (i) land related conflicts are more frequent than water related conflicts, (ii) conflicts in predominantly traditional pastoral areas — Dillo, Dida Hara and Suguta Marmar — are relatively

Figure 1. Cumulative distribution of conflict incidences reported by households



fewer compared to areas of more diverse land use patterns — Ngambo, Finchawa and Dirib Gumbo — in which cultivators and herders must co-exist (Table 1). Although a sharp minority of sample households cultivate crops, cultivators appear far more likely than herders to experience resource conflict. Overall, however, and especially between traditional pastoralist herders, resource related conflicts in these sites are not remarkably frequent.

We estimated a Poisson regression model to explore the relationship between resource conflict and household wealth, mobility patterns and resource competition. The results reveal no significant link between livestock numbers and incidence of conflicts. Thus increasing herd size is not correlated with increased frequency of conflict. This may be partly attributed to the fact that mobility to distant satellite camps appears to dampen the likelihood of conflicts over either land or water. However, resource conflict incidents over land or water were more likely to occur in communities characterized by diverse and changing resource use patterns.

Consistent with the regression evidence, when we asked households their perceptions of changes in incidence of conflict, they were split in their assessment as to whether resource conflicts between herders have been increasing or decreasing over the past decade, but they overwhelmingly perceive conflicts involving cultivators to have increased. More than three times as many people thought herder-cultivator conflicts were increasing in their community as thought such conflicts were decreasing, while nearly twice as many thought conflicts between cultivators over land or water were increasing, as compared to those who believed cultivator-cultivator conflicts to have decreased locally. In summary, resource conflict appears to be associated more with the rise of nontraditional land uses, especially crop cultivation in streambeds and valley bottoms traditionally used for grazing and watering herds, than with any growth in herd sizes associated with livestock cycles or growing pastoralist populations.

All communities experience resource conflicts at some time and most have evolved mechanisms for resolving disputes over land and water. Yet institutions may evolve more slowly than land use patterns, in which case nontraditional conflicts, such as those between cultivators and herders, may take longer to resolve than more traditional disputes between herders. Conflicts involving cultivators were significantly less likely to have been resolved at the time of our survey than were conflicts between herders (Table 2). While less than three percent of herder-herder conflicts went unresolved, conflicts involving cultivators had gone unresolved more than five times more frequently.

We used a multivariate logistic model to examine resource conflict resolution mechanisms and the likelihood of resolving disputes bilaterally, without recourse to third party

Table 1. Conflict occurrence by type and across study sties (% of sampled households).

	Diverse Land use			Traditionally Pastoral			All Sites
	FW	DG	NG	DH	SM	DL	
Cultivator-Cultivator over land (CCL)	27	35	32	24	13	3	21
Cultivator-Cultivator over water (CCW)	0	5	5	3	6	0	3
Herder-Herder over land (HHL)	23	10	0	3	41	3	15
Herder-Herder over water (HHW)	17	0	0	7	9	17	9
Cultivator-Herder over land (CH)	20	15	47	21	0	0	15
Any of the above conflicts	57	50	68	41	44	23	46

Finchawa (FW), Dirib Gumbo (DG), Ngambo (NG), Dida Hara (DH), Suguta Marmar (SM), Dillo (DL)

Table 2. Observed frequency of conflict resolution (% of all reported conflicts).

	CCL	CCW	HHL	HHW	CH
Not resolved at all	6.5	40.0	0	4.2	14.3
Solved bilaterally between two parties	19.4	20.0	28.6	16.7	19.0
Solved by third party	74.1	40.0	71.4	79.1	66.7

intermediaries. Our statistical model indicates that familial or clan relations between the parties significantly increase the probability of a conflict being resolved, as well as the likelihood that the two parties can resolve their differences bilaterally. Traditional methods of resolving resource-related conflicts between herders within familial or clan groups and even across clans, using longstanding dispute resolution institutions, thus appear to remain reasonably effective. But traditional mechanisms appear somewhat less effective in coping with the growing number of conflicts associated with new land uses in crop cultivation, especially where these conflicts occur between clans. This may reflect, in part, the absence of any formal land use policy in the arid and semi-arid lands that accommodates recent diversification in land uses.

Practical Implications

These findings underscore the importance and viability of indigenous resource management and conflict resolution mechanisms in pastoral dominated areas, the importance of maintaining pastoralist mobility so as to minimize conflict over land and water in the rangelands, and the challenge posed to pastoralist systems by the rapid emergence of crop cultivation in traditional grazing lands. The inherent spatio-temporal flexibility of pastoralism enables herders to avoid conflict and to manage it when it does occur more effectively than do other, more sedentarized communities that rely increasingly on crop cultivation and the non-agricultural economy. Pastoral communities experiencing rapid changes in land use may well need assistance in adapting traditional dispute resolution mechanisms over natural resources as such conflicts appear to be growing in frequency, and are less likely to be resolved than the more traditional herder-herder competition over land and water.

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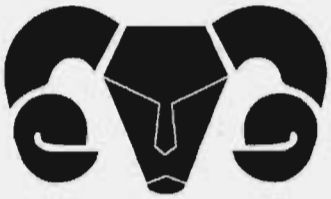

Managing Pastoral Development in Kenya: Challenges for Policy and Law

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Research Brief 04-09-PARIMA August 2004

It is argued, at least until recently, that the policy environment in Kenya has never been truly supportive of pastoral development. Successive governments have either totally neglected the arid lands or imposed inappropriate development interventions. Two major factors have contributed to this situation, namely: (1) Decision-makers lack knowledge about pastoral systems (referred to here as "the knowledge gap"); and (2) inhabitants of the rangelands lack political influence (referred to here as "the power imbalance"). Despite this history, the National Rainbow Coalition (NARC) assumed power in 2003 and the NARC appears to be endorsing pastoral development as an important item in the development agenda. Pastoral people and their advocates thus need to seize the moment and actively engage the political process to promote arid land development. It is noted that a way forward may consist of the need for government to embrace three main needs: (1) Formal recognition of pastoralism as a viable livelihood and land-use system; (2) formal recognition of the common property tenure that prevails in pastoral areas; and (3) creation of an environment whereby pastoral people and their organizations are empowered to effect their own development.

Background

Arid lands cover over 80% of Kenya and are home to about 25% of the country's population. The relations between occupants of arid lands and the state—right from the colonial times to the present—have, for the most part, been defined by the "land question." The dominant paradigm informing policy and legal approaches to land management has been predicated on "actual occupation," informed, in turn, by a cultivation mentality which sees land as undeveloped and unoccupied unless it has structures or crops placed upon it. This attitude has translated into government policies aimed at encouraging settlement in pastoral zones. Settlement of pastoralists has also been seen as a necessary condition for accessing modern social amenities like hospitals, schools, and the like. Settlements, however, have been created with little consultation, and thus with little regard, for grazing patterns and other ecological considerations, resulting in substantial disruptions to pastoral mobility and posing adverse impacts on the environment.

The problems facing pastoral development in Kenya are the same as those facing pastoral development all over the developing world. It is ironic that while pastoralists are one of the most researched societies, they remain one of the least understood. In addition to a hostile policy environment, pastoralists continue to face endemic violence caused by increasing competition over scarce resources. Pastoralism has always lacked support from the highest levels of government in Kenya, and has rarely—if ever—benefited from institutional frameworks explicitly designed to promote pastoralism as a viable form of land use and livelihoods.

The Knowledge Gap and the Power Imbalance

I believe two factors explain the situation in Kenya. First, policy makers have a poor understanding of pastoral systems, and I refer to this as the **knowledge**

gap. Second, pastoral people do not have the political leverage to ensure that policies are designed in their favor. I refer to this as a **power imbalance**.

Information alone, however, will not induce policy makers to change their policies, as policy design is essentially a political, state-driven process aimed at reconciling the divergent needs of multiple stakeholders. Thus, although policies are theoretically supposed to respond to the common needs of the nation as a whole, in practice they tend to favor the politically dominant elite whose political leverage is an intrinsic element of the policy formulation process. Thus, the lack of political leverage means that pastoralists are disadvantaged in influencing policy processes in their favor.

The power imbalance can be understood with respect to two additional phenomena. First, governments have little economic or political interest in promoting pastoral interests per se. Government tends to see pastoralists as a "minority vote" given the fact that there are relatively few pastoralists and they occupy what is considered to be marginal land with little economic potential. Second, and more importantly, there is no vibrant and effective pastoral civil society movement that is capable of engaging with the policy apparatus to represent and defend the interests of pastoral people.

An Increasing Profile for Pastoral Development

Even before the National Rainbow Coalition (NARC) came to power in 2003, a number of developments had signaled a new policy orientation with promise for arid land development in Kenya. In the process leading to the drafting of the Poverty Reduction Strategy Paper (PRSP) for Kenya, pastoralism was identified as a separate theme. A "Pastoral Thematic Group" was established to work on the specificities of pastoralism for the PRSP. The Pastoral Thematic Group then produced a Pastoral Poverty Reduction Strategy Paper (PPRSP) that was ultimately incorporated into the national PRSP, thereby ensuring that specific needs of pastoralism were identified and addressed in a manner that would not otherwise have been possible.

The same approach has been adopted in the recent Constitutional Review process, where the pastoral lobby has been one of the most organized. This has all resulted in serious attention being given to the interests of pastoralists in Kenya.

In its first major development policy statement since taking over the government, the NARC signaled early on that they took arid land development seriously. The new Economic Recovery Strategy for Wealth and Employment Creation, 2003-07 has devoted an entire chapter to arid and semi-arid lands. This is a departure from the practice of the former KANU government, which invariably treated semi-arid lands as a section within the chapter on Agriculture and Rural Development.

The Way Forward

The NARC government has given new hope and impetus for sustainable development of arid lands in Kenya. What remains is for the inhabitants of such lands to take advantage of this turn of events to improve their lot.

For the communities to take advantage of—and benefit from—the new political dispensation, it is imperative that they are sufficiently organized and have strong, well-informed, and representative organizations. Only then can they constitute a "political force" capable of engaging the State and other interest groups on a sustained basis to advance pastoral interests. Otherwise, pastoralists will remain vulnerable to other people's interpretation of what is best for them.

In this connection, it is important that pastoral communities should be directly involved in defining their development needs, building on what was put together within the framework of the PRSP and Economic Recovery Strategy. Among the priority areas for sustainable development of arid lands the following are proposed:

(a) The need to ensure **recognition of pastoralism as a viable livelihood and land-use system** within the new constitutional dispensation, and commit the Government of Kenya to protect and promote pastoralism as a way of life;

(b) The need to ensure **recognition of land-tenure systems that permit the holding of lands as common**

property in the manner proposed within the draft Constitution; and

(c) The need to design **pastoral development policy that clearly articulates the unique attributes of arid lands and promotes development interventions that empower local populations** and their institutions, and are founded on the objective reality of pastoralism.

In conclusion, it is important to appreciate that critical as it is, an appropriate national policy alone cannot deliver pastoral development. At the local level governance structures must be transformed to give greater voice and power to pastoralists and pastoral institutions.

Further Reading

This report has been edited and condensed from a public presentation now documented in the following publication:

Aboud, A.A., Gebru, G., Desta, S., and D.L. Coppock (eds). 2004. *Pastoralism in Kenya and the Policy Environment: Linking Research, Development Actors, and Decision-Makers. Summary of Proceedings.* Meeting held 8 August, 2003, at the Headquarters of the Kenya Agricultural Research Institute (KARI), Nairobi. Published by the Pastoral Risk Management (PARIMA) Project of the Global Livestock Collaborative Research Support Program (GL-CRSP). Utah State University, Logan, Utah, USA. 32 pp.

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Design by Susan L. Johnson

GLOBAL LIVESTOCK CRSP

Rectifying Distributionally Regressive Microfinance Systems in Northern Kenya

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Pastoral Risk Management Project

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The absence of financial savings and credit access is widely cited as an obstacle to poverty reduction in the rangelands of east Africa. The well-known successes of microfinance initiatives in many parts of the world hold out the promise of scale-appropriate financial services for people traditionally excluded from financial markets, such as pastoralists in northern Kenya. Yet we find that although poorer households are indeed more likely to participate in Financial Service Associations (FSAs) operating in Marsabit District, the rules governing credit access lead to high rates of default by relatively richer borrowers, leading to problems of solvency for the financial institutions and ultimately to a regressive redistribution of wealth from poorer savers to wealthier borrowers who default on loans taken out from the FSAs. Some relatively straightforward changes in lending rules could remedy this unintended and unfortunate result.

Background

Pastoralists rely heavily upon livestock to accumulate and safeguard their wealth. Yet holding livestock as the primary, if not the sole, asset exposes pastoralists to a great deal of risk, not only from disease outbreaks and low and variable rainfall, but from wildlife attacks, as well as inter-clan and intra-tribal livestock raids. Desta (1999) calculates a latent demand for savings and financial services among pastoralists of the Borana Plateau in southern Ethiopia and recommends the introduction of financial services to the region. Given the fees typically associated with financial savings in commercial banks, however, deposits of less than about 25 goats' equivalent offer negative rates of return, on average, and even deposits in excess of that generate expected returns significantly below those of livestock assets (McPeak forthcoming). Microfinance savings alternatives thus offer pastoralists some capacity to diversify risk and perhaps to enhance non-pastoral investment as well.

Between 1999 and 2001, K-REP Development Agency (KDA) opened five FSAs in Marsabit District to provide informal financial services to pastoralists. The FSA differs from some other microfinance models in that the institution is self-financed through equity capital raised from the local community, loans are issued to individuals as opposed to groups, and loan size is proportional to investment (Jazayeri, 1996). While popular microfinance models such as the Grameen Bank rely on external funds to finance loans, FSAs raise capital by selling equity shares to the local community. Members whose loan applications are accepted by the FSA's democratically-elected Board of Directors borrow from the community's investment. Principal repayments replenish the loan fund, interest and penalties collected augment it, and loans in default decrease the fund. The financial position of the FSA is reflected in share value, calculated annually by the KDA audit division. Since members share the profits and losses resulting from FSA operations, membership into the FSA, indicated by the purchase of one or more shares, is equivalent to an equity investment.

The FSA model assumes that the profit motive induces members in general, and the Board of Directors specifically, to protect the community's equity investment by harnessing local knowledge to screen out bad credit risks and exerting social pressure to ensure loan repayment. FSAs extend loans to individuals, relying upon board members to deny loan applications submitted by members with a proclivity to renege on their debt, as well as the general membership to collectively guard their equity investment by closely monitoring those who borrow. In contrast, the Grameen model requires participants to form groups prior to loan disbursement and holds the entire group responsible for loans to its individual members, in order to protect the bank against bad credit risks and moral hazard through joint group liability. FSAs formed after 2000 incorporate elements of group lending into loan design, however variation in implementation is observed at the FSA level.

Loan size determination constitutes another critical difference between FSAs and some other microfinance designs. FSA loans are directly proportional to equity investment, as opposed to the popular practice of progressive lending whereby loans start small and increase in subsequent rounds of loans conditional upon proper repayment. As a result, those who can afford to invest greater amounts in the FSA enjoy access to larger loans. This feature of the FSA was designed to stimulate investment from the community, enlarging the loan fund available to members.

Major Findings

Using data collected from 282 FSA members and 292 nonmembers from thirteen FSAs in three districts of Kenya, including four FSAs in Marsabit District, we find that relatively poor households are more likely to purchase FSA shares than are wealthier households. In this sense, FSAs extend accessible financial instruments to the poor.

However, among those who self-select into FSA membership, the relatively wealthy purchase more shares than do the relatively poor. Sixty percent of FSA members own only a single share. Since loan size is limited by shareholdings, wealthier members can borrow more from the FSA, irrespective of creditworthiness.

Table 1 divides loans accessed by members into share holding categories. Of the 180 members who own a sole share, only 12 percent took out a loan. In contrast, of the 70 members who hold between two and five shares, 36 percent borrowed from the FSA, as did 64 percent of the 48 members holding more than five shares. Not only do those with larger shareholdings tend to borrow more frequently than do those with only one share, they also borrow at larger amounts, since current FSA rules set borrowing limits as a function of shareholdings. Seven members owning greater than ten shares a piece received eleven loans worth 26 percent of total loan value issued by all the FSAs. Less than 9 percent of the members received more than 48 percent of all the loaned funds. Although the poor are more likely to become FSA shareholders, wealthier FSA members are more likely to take out loans and the loans are, on average, significantly larger. The value of the poor's equity investment in FSAs thus depends fundamentally on the loan repayment performance of their relatively better-off neighbors.

To understand this performance better, we studied the details of every one of the 901 loans issued by ten FSAs, including all five FSAs in Marsabit District. Table 2 depicts loan repayments by loan size. Loans of 1,200Kshs or less (the maximum loan available to 60 percent of members who own only one share) defaulted at rate of 39 percent. Loans of 15,000Kshs, available only to the wealthiest 3 percent of FSA members, defaulted at a rate of 53 percent. Overall, 41 percent of loans at least partly defaulted, leading to substantial losses of share value (Osterloh 2001, 2004). Clearly shareholdings, though strongly correlated with a household's wealth and cash income, is not a good indicator of a member's propensity to repay.

High rates of default on large loans have serious repercussions for the financial viability of FSAs. Table 3 illustrates distribution of loans and loans in arrears by loan size. The 269 smallest loans of 1,200 Kshs or less represent a mere 7 percent of FSA share value disbursed as loans. In contrast, the 200 loans greater than or equal to 10,000 Kshs comprise 60 percent of the principal borrowed. The value of the principal in arrears of the 20 loans greater than 15,000 Kshs in default (286,006 Kshs), is comparable to the total principal paid out in the smallest 269 loans (304,450 Kshs). The delinquent principal of these twenty large loans in default represents 14 percent of the total share value of

Table 1: Loans and loan values across shares.

SHARES	Number of Members	% Members	% Members Borrowing	Number of Loans	Value of Loans (Kshs)	% Value of Loans
1	180	60%	12%	25	39800	9%
2	37	12%	30%	18	32500	7%
3	23	8%	39%	11	42500	9%
4	10	3%	40%	7	25500	5%
5	13	4%	62%	12	56400	12%
6	8	3%	63%	8	47400	10%
7	3	1%	67%	2	15400	3%
8	3	1%	67%	3	22200	5%
9	3	1%	67%	2	22000	5%
10	7	2%	57%	9	40000	9%
10+	11	4%	64%	11	123000	26%
TOTAL	298			108	466700	

Table 2. Loans in default across loan size.

LOAN SIZE (Kshs)	1,200 and less	up to 3,600	more than 3,600
Shares Required for Loan	1	2 to 3	4 or more
Number of Loans	269	248	384
Loan Value, Kshs	306,450	667,150	3,662,200
% of Total Loans Disbursed	7%	14%	79%
% Loans in Arrears	39%	39%	45%
Value in Arrears/ Total Value	26%	25%	28%

the ten FSAs combined. FSA history suggests that a few large, delinquent borrowers can threaten the viability of the institution.

How do we explain such significant rates of loan default given that the industry standard as set by the Grameen Bank hovers around two percent? Microfinance relies upon communities to exploit indigenous knowledge about participants' credit-worthiness to screen out borrowers with high ex-ante levels of risk. However, fewer than three percent of loan applications among northern FSAs are rejected, providing scant evidence of loan screening by board members. In addition, regular loans issued after review and approval by the Board of Directors default at the same rate as emergency loans issued at the discretion of the Manager, further corroborating the observation that the current loan screening process is ineffectual.

Mude (2003) considers the effect of social norms upon FSA board member incentives to screen loan applicants and monitor borrowers. In the context of the study area, as well as in other poor rural areas frequently targeted by microfinance initiatives, the norm of assisting those who request aid strongly colors social interactions. Mude theorizes that FSA Board Members responsible for loan screening and delinquent loan collection have little incentive to screen out poor credit risks and to pursue defaulters if the disutility personally borne by board members for denying assistance or harassing defaulters for loan repayment is large. In particular, if these social costs to the board members are greater than the erosion of share value resulting from loans in default, the cost of which is divided amongst the entire FSA membership, then the decision to extend loans to risky borrowers is individually rational for the board members. If social status and wealth indicate capacity to reciprocate assistance in the future, then the social costs of refusing large loans to the relatively rich are higher than refusing poorer members smaller loans, and board members accrue social capital by granting and/or neglecting to collect big loans. Mude's model explains the prevalence of loans amongst large shareholders and the high rate of loan application acceptance observed at FSAs as a result of social pressures which lead to ill-conceived loans supplied to relatively wealthy, more influential borrowers.

In conclusion, although the relatively poor are more likely to become FSA members through share purchases, relatively wealthier members are more likely to purchase multiple shares and to borrow from FSA equity capital. Since shareholdings determine loan limits, the relatively wealthy take out larger loans. They also default at a somewhat higher rate than do poorer borrowers who take out smaller loans. As a consequence, under their present design, northern Kenyan FSAs redistribute wealth regressively from equity shares purchased by the poor through loans taken out by, and defaulted on disproportionately by, better off households.

Practical Implications

The distributionally regressive effect of current FSA savings and lending practices could likely be rectified through modest changes to loan rules. In particular, it would help to redesign the loan distribution mechanism by issuing small loans to new borrowers and using initial loans to gather information about the members' propensity to repay. Reserving larger loans for those with established credit repayment histories, might well reduce loan default rates and better safeguard the assets of the poor. To increase the loan repayment rate, rigorous application of the group lending paradigm would transfer costs of screening and monitoring from the Board of Directors to lending groups and create group incentives to assure member loan performance.

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Design by Susan L. Johnson

GLOBAL LIVESTOCK CRSP

Rectifying Distributionally Regressive Microfinance Systems in Northern Kenya

Sharon Osterloh, Cornell University
Pastoral Risk Management Project

Research Brief 04-10-PARIMA August 2004

The absence of financial savings and credit access is widely cited as an obstacle to poverty reduction in the rangelands of east Africa. The well-known successes of microfinance initiatives in many parts of the world hold out the promise of scale-appropriate financial services for people traditionally excluded from financial markets, such as pastoralists in northern Kenya. Yet we find that although poorer households are indeed more likely to participate in Financial Service Associations (FSAs) operating in Marsabit District, the rules governing credit access lead to high rates of default by relatively richer borrowers, leading to problems of solvency for the financial institutions and ultimately to a regressive redistribution of wealth from poorer savers to wealthier borrowers who default on loans taken out from the FSAs. Some relatively straightforward changes in lending rules could remedy this unintended and unfortunate result.

Background

Pastoralists rely heavily upon livestock to accumulate and safeguard their wealth. Yet holding livestock as the primary, if not the sole, asset exposes pastoralists to a great deal of risk, not only from disease outbreaks and low and variable rainfall, but from wildlife attacks, as well as inter-clan and intra-tribal livestock raids. Desta (1999) calculates a latent demand for savings and financial services among pastoralists of the Borana Plateau in southern Ethiopia and recommends the introduction of financial services to the region. Given the fees typically associated with financial savings in commercial banks, however, deposits of less than about 25 goats' equivalent offer negative rates of return, on average, and even deposits in excess of that generate expected returns significantly below those of livestock assets (McPeak forthcoming). Microfinance savings alternatives thus offer pastoralists some capacity to diversify risk and perhaps to enhance non-pastoral investment as well.

Between 1999 and 2001, K-REP Development Agency (KDA) opened five FSAs in Marsabit District to provide informal financial services to pastoralists. The FSA differs from some other microfinance models in that the institution is self-financed through equity capital raised from the local community, loans are issued to individuals as opposed to groups, and loan size is proportional to investment (Jazayeri, 1996). While popular microfinance models such as the Grameen Bank rely on external funds to finance loans, FSAs raise capital by selling equity shares to the local community. Members whose loan applications are accepted by the FSA's democratically-elected Board of Directors borrow from the community's investment. Principal repayments replenish the loan fund, interest and penalties collected augment it, and loans in default decrease the fund. The financial position of the FSA is reflected in share value, calculated annually by the KDA audit division. Since members share the profits and losses resulting from FSA operations, membership into the FSA, indicated by the purchase of one or more shares, is equivalent to an equity investment.

The FSA model assumes that the profit motive induces members in general, and the Board of Directors specifically, to protect the community's equity investment by harnessing local knowledge to screen out bad credit risks and exerting social pressure to ensure loan repayment. FSAs extend loans to individuals, relying upon board members to deny loan applications submitted by members with a proclivity to renege on their debt, as well as the general membership to collectively guard their equity investment by closely monitoring those who borrow. In contrast, the Grameen model requires participants to form groups prior to loan disbursement and holds the entire group responsible for loans to its individual members, in order to protect the bank against bad credit risks and moral hazard through joint group liability. FSAs formed after 2000 incorporate elements of group lending into loan design, however variation in implementation is observed at the FSA level.

Loan size determination constitutes another critical difference between FSAs and some other microfinance designs. FSA loans are directly proportional to equity investment, as opposed to the popular practice of progressive lending whereby loans start small and increase in subsequent rounds of loans conditional upon proper repayment. As a result, those who can afford to invest greater amounts in the FSA enjoy access to larger loans. This feature of the FSA was designed to stimulate investment from the community, enlarging the loan fund available to members.

Major Findings

Using data collected from 282 FSA members and 292 nonmembers from thirteen FSAs in three districts of Kenya, including four FSAs in Marsabit District, we find that relatively poor households are more likely to purchase FSA shares than are wealthier households. In this sense, FSAs extend accessible financial instruments to the poor.

However, among those who self-select into FSA membership, the relatively wealthy purchase more shares than do the relatively poor. Sixty percent of FSA members own only a single share. Since loan size is limited by shareholdings, wealthier members can borrow more from the FSA, irrespective of creditworthiness.

Table 1 divides loans accessed by members into share holding categories. Of the 180 members who own a sole share, only 12 percent took out a loan. In contrast, of the 70 members who hold between two and five shares, 36 percent borrowed from the FSA, as did 64 percent of the 48 members holding more than five shares. Not only do those with larger shareholdings tend to borrow more frequently than do those with only one share, they also borrow at larger amounts, since current FSA rules set borrowing limits as a function of shareholdings. Seven members owning greater than ten shares a piece received eleven loans worth 26 percent of total loan value issued by all the FSAs. Less than 9 percent of the members received more than 48 percent of all the loaned funds. Although the poor are more likely to become FSA shareholders, wealthier FSA members are more likely to take out loans and the loans are, on average, significantly larger. The value of the poor's equity investment in FSAs thus depends fundamentally on the loan repayment performance of their relatively better-off neighbors.

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