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

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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.

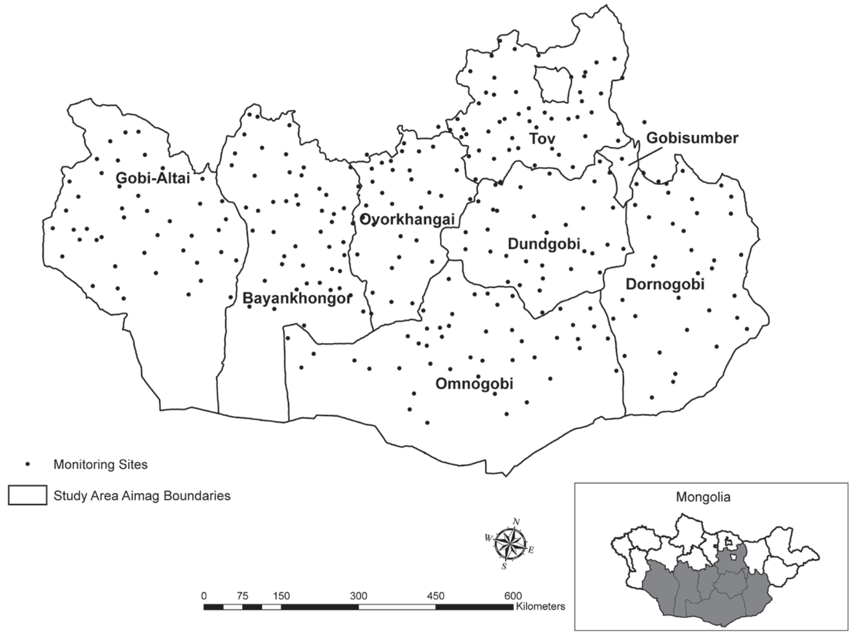
Due to the physical conditions encountered in Mongolia, the Gobi team conducted a more rigorous model and map validation than was done in East Africa. Each monitoring site was visited at least twice during the study period, and some sites were visited up to five times. The short growing season (90 to 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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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 East and West Africa, Central Asia and Latin America.

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