

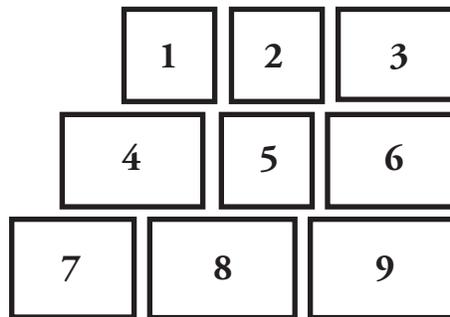
ANNUAL REPORT 2006 GLOBAL LIVESTOCK CRSP

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ANNUAL REPORT 2006



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PREFACE

Each year, the Global Livestock Collaborative Research Support Program publishes an annual report in compliance with grant requirements. The 2006 Annual Report documents work completed during the fiscal year, October 2005 - September 2006. The principal investigators for each project submit reports on research conducted with GL-CRSP funding. Each report is the expression of the principal investigator with minor editing by the Management Entity. Each project report gives the name, address, telephone, fax number and email address of the principal investigator for that project. Inquiries are welcome.

Special thanks goes to David Wolking who worked extensively on the editing and formatting of the document.

Susan L. Johnson
Annual Report Coordinator

FOREWORD

HIGHER EDUCATION AND DEVELOPMENT IN AFRICA

*By Dr. Montague W. Demment
Director, Global Livestock CRSP*

One of the conundrums of the development agenda today is the lack of focus on higher education in development. I see this as a major impediment to development in Africa. While we all recognize the role of higher education in our own country's economic growth and future competitiveness, that support does not translate into our vision for developing countries. The recent 2005 United States Agency for International Development Education Strategy: Improving Lives through Learning places strong emphasis on basic education but scantily mentions or recognizes the role of higher education in international development. As a university faculty member and as director of an international development program, I am troubled that the present level of emphasis on higher education will not support nor sustain the new mission statement of United States Agency for International Development (USAID): "helping to build and sustain democratic well governed states that will respond to the needs of their people and conduct themselves responsibly in the international system."

Much greater support for basic education exists in Congress and the development community than for higher education. Based on very limited work in the late 1970s, basic education was found to have a higher rate of return than higher education. Donors focused on those studies to promote basic education. No doubt basic education is critical for development, but as opposed to competing with higher education, the development portfolio should be a balanced continuum of opportunity that allows the best and brightest to succeed. In fact, higher education should be viewed as a means to maximize the gains in basic education by producing the economic growth that will sustain basic education after development assistance ends. In an information

world with a global economy, higher education is critical to developing businesses, negotiating treaties and contracts, and creating the stability that is necessary for comprehensive national development. "Higher education produces the entrepreneurs, the creative thinkers, and the business leaders that generate economic growth and turn poor countries into prosperous ones. Tertiary education exercises a direct influence on national productivity, which largely determines living standards and a country's ability to compete in the globalization process."¹

Unfortunately donor support for higher education degree training continues to wane. USAID's efforts in this regard have diminished substantially. The Agency has gone from training more than 15,000 students per year who earned higher education degrees in the early 1990s to less than 1,000 today. Many African countries struggle to maintain even low enrollment levels, and the academic research output in the region is among the world's lowest.

Africa faces a multitude of challenges that will affect how successful development efforts will be. Clearly, agriculture is key to making that development successful. Successful agricultural development is most directly achieved through investments in human and institutional capacity that will generate the knowledge, technology, and leaders to eradicate famine and food shortages, and build economies that support stable and democratic societies in Africa.

We need to reengage the power of our U.S. Land-Grant institutions to assist Africa in building its higher education and research institutions, and in training another generation of scientists and academics to lead a new green revolution for Africa.

The Power of Agriculture Growth

In a broad review of African development, a recent International Food Policy Research Institute (IFPRI) study² shows that agriculture is truly an important engine for growth. While its role may vary among countries depending on a diversity of conditions, agriculture is an especially strong force in poverty reduction, as it affects the rural poor, who are the largest portion of the poor in Africa. The study concludes “most African countries cannot significantly reduce poverty, increase per capita incomes, and transform into modern economies without focusing on agricultural development.” This conclusion is similar to that of another study³ of a broad range of developing countries, which found that increasing agricultural productivity is the most efficient way to reduce poverty and inequality.

Yet another study⁴ of 62 developing countries demonstrates the power of agricultural development to increase national economic growth. The study shows that changes in agricultural productivity explained 54 percent of the growth in GDP per worker, and that this increased efficiency, and released labor from agriculture to other sectors that accounted for another 29 percent of the GDP growth. The remaining 17 percent of GDP growth came from non-agricultural increases.

Agriculture does not just grow economies, it measurably improves human lives. A secure and diverse food supply increases child survival, improves cognitive and physical development of children, and increases immune system function, including resistance to HIV/AIDS (a secure food supply also has an impact on the trajectory of this and other diseases).

The importance of food cannot be underestimated. In the GL-CRSP Child Nutrition Project (CNP)⁵ study in Kenya, children who received 2 oz of meat on school days (2/3 of the calendar days) performed 20 percent higher on intelligence scores, and achieved an increase of a grade-and-a-half higher in school performance. Think of the implications of that impact on creative capacity to compete in a knowledge based world when integrated to the national level; then think of the costs on chronic malnutrition to a national economy, not only in lost

potential, but in health care costs, lost productivity, and wasted lives.

Perhaps the most important revolution of the 20th century was a peaceful and green one at that. Dr. Norman Borlaug used advanced breeding techniques to redesign the wheat plant and make it considerably more productive, more adaptive to wide range of environments, and more disease resistant (funded by USAID, and the Rockefeller and Ford Foundations). Dr. Borlaug received the Congressional Gold Medal for his work (the highest civilian award by Congress). Part of Borlaug’s genius was his complete dedication to building human capacity in science that both advanced his vision more rapidly, and left a sustainable research capacity for developing countries. It is when research, human, and institutional capacity are wed that science can generate solutions to human problems, and it is when those elements are present in developing countries that we see major advances like those that Borlaug generated. Due to Norman Borlaug, the post war famines of Asia were extinguished in the early 1970s. For this effort Borlaug received the Noble Peace Prize in 1970.

Contrary to present day wisdom, which says that the answer to the development challenge is only through policy and market connectiveness, we also need substantial increases in agricultural productivity. Most of the recent gains in agricultural production in Africa have resulted from expanding the area of land cultivated, not through increasing the production per unit of land area. The negative implications include not just a decline in per acre production efficiency, but also the use of more marginal land with ever increasing negative impacts on the natural resource base, biodiversity, and water quality.

Increases in efficiency per acre are the result of improved technologies and access to inputs. The sustainable way to increase efficiencies is to create African capacity to generate new technologies; that is build the human capacity and build the institutions that generate that capacity—the universities and the agricultural research institutes. We need to make such investments. Evidence from rural Uganda indicates that public investments in agricultural R&D had the highest impact on poverty reduction of development investments throughout

the 1990s.⁶ In addition to financial resources, agricultural innovation requires human capital, and therefore, sustaining and improving upon advances in agricultural R&D requires concurrent investments in general education.⁷ It is the flexibility of creativity produced by human capacity that makes adaptation to change possible. In short, the most effective means to address the expanding footprint of climate change on Africa is through investments in education and human and institutional capacity.

How does research and higher education contribute?

1. **Higher education builds human capital** at a level that is necessary to compete in a global economy. Global economic engagement requires sophisticated business knowledge, the ability to meet international standards of quality, negotiate appropriate agreements, craft complex financial mechanisms, understand and interpret the rules of engagement, and to be both entrepreneurial and competent. Increased human capacity to conduct these endeavors will facilitate greater participation in global markets for the poor countries of the world. These are the job creators for all the basic education graduates currently being produced with the laudable emphasis on basic education.

2. Just as human capital is necessary to conduct business, it is critical to **build and maintain the institutions** that generate new knowledge and technology, establish and maintain standards, create laws, and conduct business in ways that resemble U.S. and international norms. Well-trained people create and sustain functional institutions that promote good economies and support good governance. Of USAID's 40-year investment in higher education degree training, an outside review concluded: "Change at the institutional level of this magnitude is unusual in human resources and training programs and testifies to the extraordinary impact the ATLAS/AFGRAD programs had in Africa."⁸

3. **Higher Education and research institutes generate knowledge** that has economic impact, particularly in agriculture. In a study⁹ of more than 1,800 rates of return to research in agriculture, the median of the rate of return estimates was 48 percent

per year for research, 62.9 percent for extension studies, 37 percent for studies that combined research and extension jointly, and 44.3 percent for all studies combined; a profitable investment by any standards but particularly so for a developing country.

4. In a USAID commissioned evaluation of more than 3,000 African higher education trainees educated in U.S. universities and supported by USAID, the evaluators found that the training had a marked effect on **the impact of individuals**, in building stronger institutions, and had a lasting impact on economic development and social contributions.¹⁰ The experience of training in the United States had numerous benefits beyond the technical skills acquired. A number of positive aspects of efficiency and views of democracy were associated with links to an American education.

Investing in higher education in developing countries is a critical component to long-term economic growth and stability, and crucial to agricultural development and poverty reduction. Investments in tertiary education promote "technological catch-up," allowing countries to gain ground on more technologically advanced societies and maximize economic output. To illustrate the economic growth potential of tertiary education on GDP, a one-year increase in tertiary education stock would raise steady-state levels of African GDP per capita by 12.2 percent due to factor inputs, potentially boosting incomes by 3 percent after five years, a significant feat considering the trend towards decreasing incomes in some African countries.¹¹

In developed countries this effect has been well measured. According to the U.S. Census Bureau, high school graduates earn an average of \$1.2 million, associate's degree holders earn about \$1.6 million, and bachelor's degree holders earn about \$2.1 million over an adults working life.¹² In the United States, average rates of return on investment for post-secondary education increased from 5.6 percent in 1979 to 9.1 percent in 2004, consistent with average international rates of return across nine countries estimated at 9 percent.¹³ The increases in rates of return likely reflect the increasing importance of education in a technology and knowledge-based global economy.

Perhaps the greatest contribution of higher education, however, is manifested in the indirect benefits to society. Based on a Carnegie Institute report,¹⁴ post-secondary education influences individual behavior, encouraging more open-minded, cultured, rational, and consistent individuals with less authoritarian tendencies. In addition, university enrollment has demonstrated a tendency to decrease prejudice, improve knowledge of global affairs, and improve social status. These benefits are in turn passed along to succeeding generations. Leadership training provides countries with talented individuals able to establish policy environments favorable to growth and sustainability. The promotion of education and literacy also encourages a social environment with an increased capacity for tolerance and understanding, and diminished tendencies towards prejudice and misconception, constructing a well-informed society with the ability to think critically and objectively, establishing the foundation for democracy: a critical component of developing a more secure and stable world.

FOOTNOTES

¹World Bank 2002. *Constructing Knowledge Societies: New Challenges for Tertiary Education*. World Bank, Washington, D.C.

²Diao et al. 2006. *The role of development: implications for Sub-Saharan Africa*. DSGD Discussion Paper No. 29, IFPRI, Washington, D.C.

³Bourguignon, F., and Morrisson, C. 1998. "Inequality and Development: The Role of Dualism", *Journal of Development Economics*, 57(2), 233-258.

⁴Gollin, D., Parente, S., and Rogerson, R. 2002. "The Role of Agriculture in Development", *American Economic Review*, 92(2): 160-164.

⁵Demment, M and Allen, L., 2003. *Animal Source Foods to improve micronutrient nutrition and human function in developing countries*. *J. Nutrition* 133 No 11s-11 (Special Volume).

⁶Fan, S., Zhang, X., and Rao, N. 2004. "Public Expenditure, Growth and Poverty Reduction in Rural Uganda." *Development Strategy and*

Governance Discussion Paper No.4, IFPRI: Washington, DC.

⁷Hayami, Y. and Ruttan, V. 1985. *Agricultural Development: An International Perspective*. Baltimore, Maryland: Johns Hopkins University Press.

⁸Aguirre International 2004.

⁹Alston et al. 2000. *A Meta analysis of rates of return of agricultural R&D*. IFPRI Research Report 113, Washington, DC.

¹⁰Aguirre International under the Global Evaluation and Monitoring IQC, Contract FAO-I-00-99-00010-00, Task Order 13. 2004. *Generations of Quiet Progress: The Development Impact of U.S. Long-Term University Training on Africa from 1963 to 2003: An evidence-based impact assessment of the value obtained from major investments in graduate education for 3,219 African professionals by USAID and its partners in the ATLAS and AFGRAD program*.

¹¹Bloom, D., Canning, D., and Chan K. (2006). *Higher Education and Economic Development in Africa*. World Bank Human Development Sector, Africa. [On-line]. Available: <http://www.sciencedev.net/Docs/Higher%20Education%20and%20economic%20developmnet.pdf>

¹²Day, J.C., and Newburger, E.C. (2002). *The Big Payoff: Educational Attainment and Synthetic Estimates of Work-Life Earnings*. (Current Population Reports, Special Studies, P23-210). Washington, DC: Commerce Dept., Economics and Statistics Administration, Census Bureau. [On-Line]. Available: <http://www.census.gov/prod/2002pubs/p23-210.pdf>

¹³Hamermesh, D. (2005). *Four Questions on the Labor Economics of Higher Education*. Secretary of Education's Commission on the Future of Higher Education. [On-Line]. Available: <http://www.ed.gov/searchResults.jhtml>

¹⁴Rowley, L.L., and Hurtado, S. (2002). *The Non-Monetary Benefits of an Undergraduate Education*. University of Michigan: Center for the Study of Higher and Postsecondary Education.

PROGRAM OVERVIEW

The Global Livestock CRSP has expanded its research to address important topics in the international livestock development sector. The program, comprised of broad-based interdisciplinary projects, focuses on human nutrition, economic growth, environment, and policy linked by a global theme of agriculture at risk in a changing environment. The projects involve researchers from 14 U.S. universities, 9 host country universities, 2 international agricultural research centers, 8 international research organizations, and 64 foreign institutions. The program is active in four regions of the world: West and East Africa, Central Asia, and Latin America.

HISTORY

Established in 1978 as the Small Ruminant CRSP, the Global Livestock CRSP is one of nine CRSP programs developed under Title XII of the International Development and Food Assistance Act of 1975. The CRSP model, pioneered by the SR-CRSP, was built on the structural strengths of U.S. land-grant universities and collaborative partnerships with international organizations. Four characteristics ensure the effectiveness of this model: 1) Collaboration with U.S. land-grant universities; 2) International training; 3) Long-term scientific relationships; and 4) Program cost-effectiveness.

REENGINEERED

In 1995, the CRSP began a major restructuring of the program in response to USAID's own reengineering efforts and the changing needs of the international development community. The process, a comprehensive planning and assessment procedure, was initiated with priority-setting workshops in the three regions. As forums for client input, the workshops were intended to maximize the opportunity of regional professionals to present their views on the development issues confronting them. The problem models they developed established the scope for activities within the region. Assessment teams, selected in an initial competition, developed projects that addressed the top priorities within the regions. The problem model was the central component of the assessment process. Each team was charged with refining its problem model through in-field explorations. To ensure grassroots input, over 20 regional workshops involving 35 countries were conducted during the assessment period. The teams submitted final proposals, competing to be in GL-CRSP's current grant, and winners were selected. The process was designed to be problem-driven and has produced results-oriented projects.



PROGRAM GOALS

The goal of the GL-CRSP is to increase food security and improve the quality of life of people in developing countries while bringing an international focus to the research, teaching, and extension efforts of U.S. institutions. This goal is to be achieved through collaboration between U.S. universities and other institutions, and national and regional institutions abroad that are active in livestock research and development.

STRATEGIC OBJECTIVES

To achieve this goal, the following objectives have been identified:

- Improve the interaction between livestock production and natural resource use and conservation, and more effectively integrate livestock production systems with the rational use of natural resources, such as wildlife and water.
- Decrease poverty and increase the security of people whose livelihoods depend on livestock by providing mechanisms to manage risk.
- Enhance the nutritional status - and decrease morbidity and mortality - of targeted populations, particularly children and women, through increased availability and utilization of animal source products, thereby increasing human capacity.
- Strengthen the ability of institutions in developing countries to identify problems in livestock production and develop appropriate solutions.
- Provide support to decision makers in developing policies that will promote: a) livestock production, marketing, and trade; b) human nutrition and child physical and cognitive development; and c) natural resource conservation and management.
- Develop and strengthen communication systems (including but not limited to extension) among livestock producers, policy makers, businesses, researchers, and consumers that promote greater market participation, increase human and institutional capacity, and improve policy.

GLOBAL PLAN

The Global Livestock CRSP global program builds effectively on complementarities between projects in different regions. Centered on a theme of managing risk in our unpredictable world, the program is developing the capacity to predict risk so it can be better managed, improving the tools to cope with risk, and contributing to the mediation of risk. The GL-CRSP has chosen to work in ecosystems and regions where human populations and natural resources are most vulnerable, and in most cases, where biodiversity is most valuable. The GL-CRSP focuses on human nutrition, economic growth, environment and policy related to animal agriculture and linked by a global theme of managing risk in a changing environment.

TRAINING PLAN

The Global Plan recognizes human capacity building as a fundamental component of research and development. Training has always been a key component of the CRSP portfolio. The GL-CRSP design provides for a wide range of training possibilities and employs both traditional and innovative strategies to achieve its training goals.

Degree Training. The GL-CRSP provides funding for operational and research costs to both U.S. and host-country graduate students. Projects are encouraged to leverage funds to support tuition.

Non-Degree Training. Short-term training provides a cost effective means to build capacity. Training workshops and courses build capacity for not only students but host country professors, researchers and other development professionals.

The Jim Ellis Mentorship Program. Named in honor and memory of Dr. Jim Ellis, a renowned scientist, mentor and GL-CRSP principal investigator, these awards provide partial support to students in order to improve the overall quality of their research. The Program provides funds to conduct research in specialized facilities or field settings away from their home campuses and to provide opportunities for greater diversity in collecting and more creativity in analyzing data than would otherwise be possible. The awards are intended to provide supplemental funds for students already working on GL-CRSP projects.

Travel Grants for Students. To encourage student participation at the GL-CRSP conferences, a select number of travel grants are awarded to students for presentation of their findings at the conferences. The awards permit students to inform others about their research and bring them in contact with researchers from other disciplines and other projects.

Build Capacity of Institutional Partners. The GL-CRSP goal is to build both human and institutional capacity simultaneously within host-country partner institutions. Selective targeting of funds through project funding and program enhancement address key deficiencies within these partner institutions.

CHARACTERISTICS OF GL-CRSP PROJECTS

The Global Livestock CRSP incorporates a broad and complex perspective on international development based on the following principles:

- Research should be demand-driven and problem-oriented, with considerable resources invested in problem assessment at the grass roots level.
- Impact should emphasize human outcomes, involvement of local communities, facilitation of research-extension links, and the building of partnerships with other stakeholders.
- Identification and communication of relevant policy issues should be a critical component of project planning and implementation.
- Integration of gender concerns and appropriate gender analysis should be an integral part of project research and results.

GLOBAL LIVESTOCK CRSP PROJECTS

The Global Livestock CRSP program is not a static set of activities but a constantly evolving and dynamic array of problem-focused projects. The iterative process that developed the original core of projects in 1997 continues as new research findings guide the GL-CRSP portfolio. In addition to the core portfolio of projects, the GL-CRSP also funds assessment team projects and a limited number of small grant projects on topics of special interest.

Assessment Team Projects. Before a project begins its research program, it completes a short assessment phase, usually three to nine months. During this phase, teams are given modest resources to conduct in-country workshops, planning and assessment. This process allows the teams to refine the problem model iteratively, determine and adjust team composition to fit the evolving problem model and ensure that colleagues are compatible and the team is functional. These teams then produce a research proposal for a final competition.

STRUCTURE

The Global Livestock CRSP is administered as a grant to the University of California, Davis, which, as the Management Entity, administers subgrants to participating U.S. institutions and maintains fiscal responsibility.

The *GL-CRSP Program Director* is responsible for program development, coordinating activities of the projects across and within regions, and overseeing the daily operations of the GL-CRSP.

The *External Program Administrative Council* provides advice and guidance on the scientific management of the Global Livestock CRSP.

The *Technical Coordinating Committee* provides intellectual exchange and input on programmatic planning for the CRSP to the Program Director and the Program Administrative Council.

The *Pool for External Evaluation of Research* provides objective evaluations of the CRSP programmatic process on an as-needed basis.

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**ENAM IN AFRICA: ENHANCING CHILD NUTRITION
THROUGH ANIMAL SOURCE FOOD MANAGEMENT**

NARRATIVE SUMMARY

Formative research in three regions of Ghana documented a perceived lack of income as the primary constraint to households' ability to incorporate adequate amounts of animal source foods (ASF) in young children's diets. Financial and technical support for caregivers' income generation activities (IGA) were identified as a priority for enhancing ASF intakes among 2-5 years old in the project's six intervention communities. A qualitative review of micro-credit/finance activities in Ghana was completed during the first year of the ENAM project which provided recommendations for the implementation of micro-credit/finance interventions. These recommendations included involvement of beneficiaries in the selection of IGA; extending credit facilities to individuals within solidarity groups where members serve as guarantors for each other's loans; and weekly repayment schedule for loan recuperation. Most of ENAM activities in the second year have focused on implementing these recommendations and establishing micro-credit programs for caregivers of 2-5 year-old children in our intervention communities. The project assisted caregivers of 2-5 year-old children in selecting viable IGA, developing intervention packages (entrepreneurial and nutrition education program with the intervention caregivers) for the different IGA selected, forming credit and savings associations (CSA) comprising of 4-8 solidarity groups (SG) of 3-5 caregivers in each of the intervention communities; and extending loan/credit facilities to the individual caregivers within the groups. For the nutrition education component an educational flip-chart for use with the intervention caregivers was completed and implemented during the project's second year. The entrepreneurial education program was initiated

and is anticipated to be completed early in the third year of the project. Research activities during the second year included completion of intervention-specific baseline data collection on selected caregiver/child pairs in the project's intervention and control communities, and the first of three planned quarterly follow-up data collections in one study area. Additionally, the Ghana-based graduate students completed their field data collection in the ENAM project communities and are in the process of analyzing their data. The Ugandan graduate student successfully defended his research proposal and has begun his data collection in the Kamuli District in Uganda. The US- and Ghana-based PIs and the program manager traveled to Uganda to assess the Ugandan student's progress in his field data collection and to meet with key personnel from Makerere University and some NGOs to discuss potential for future collaborations on ASF-related issues. The project has initiated support for two additional Ghanaian graduate students (one is pursuing a masters degree in Agricultural Economics and the other a degree in Nutrition) to develop research projects on ENAM project-related topics. Finally, the ENAM project developed a proposal and course outline for a nutrition extension course entitled 'Nutrition, Sustainable Livelihoods, and Extension' that will introduce students to nutrition and extension concepts within the sustainable livelihoods framework. The course proposal was submitted to the Faculty of Science academic board for review and has been approved. It will be offered through the Department of Nutrition and Food Science at University of Ghana, Legon as a third year (level 300) undergraduate course, starting August 2007.



RESEARCH

The Workplan for 2005-2006 included four principal areas of activity. The development of each of these activities is discussed in the text below

1. Administrative set-up of GL-CRSP project in Ghana
2. Development of community-based activities to improve interventions
3. Training
4. Curriculum (Nutrition Extension) development

Activity One: Administrative set-up of GL-CRSP project in Ghana and establishment of liaisons with organizations to support grant activities

Problem Statement and Approach. There was an effort to establish partnerships with institutions that were working in the research areas and had relevant experiences in extension and development. In addition, there was recognition that the University of Ghana provides a valuable institutional resource in sub-Saharan Africa in the area of community-based nutrition and agriculture extension. The project is working to develop linkages between the University of Ghana and other universities and non-governmental organizations (NGO) in Ghana and Uganda to improve child nutrition. This has occurred through educational (student and professorial) exchanges, and collaboration on research and community development activities.

Planned activities. The project sought to establish liaisons with governmental and NGOs to support grant activities. This included continued communication to develop collaborations with 1) governmental NGOs working in the study area (especially, MOFA, Ghana Health Services, Adventist Development and Relief Agency (ADRA)- working in the Central Region, and Heifer International - working in the Brong-Afaho Region); 2) initiate collaborations between University of Ghana and Makerere University in Uganda, 3) establish linkages with NGOs in Uganda.

Importance. Collaborations between the project and activities of other institutions will help efficiently use available resources, strengthen project activities,

widen their outreach, and maximize the effectiveness of the interventions.

Plans to accomplish activity. The Ghana-based staff (led by Drs. Colecraft and Sakyi-Dawson) scheduled meetings throughout the year with the Ghanaian NGOs to discuss collaboration opportunities. The regional officers were responsible for interacting with the local ministerial staff to involve them in project activities. Dr. Marquis arranged the September 2006 trip to Uganda to examine collaborative efforts between University of Ghana and Makerere University and the NGO, Volunteer Efforts for Development Concerns.

How the problem model has been modified based on last year's activity. The problem model has not been modified.

Progress. Collaborative efforts are in progress between the ENAM project and institutions.

Planned outputs and completion of tasks. The planned outputs were 1) discussions with governmental and non-governmental organizations about collaborative field efforts in Ghana and Uganda and 2) joint-institution proposals for community-based activities in Ghana and Uganda.

Activities with Ghanaian institutions. We had expected to train MOFA staff so that they would play a more direct role in the education component of the intervention. However, this proved to be unsustainable as MOFA did not have the resources to permit their staff to be in our intervention communities on a weekly basis. Thus, the project continues to interact with MOFA and share our resources with them (as well as with Ghana Health Services), but the weekly educational activities are carried out by ENAM staff.

The plans to partner with NGOs that had experience in community development and running interventions on IGA in our study areas were not able to be fully realized because of limitations with the core ENAM budget last year. However, additional funds became available through the USAID gender initiative and a proposal was submitted and approved to fund two specific NGO-collaborative activities.

1) The ENAM project has an on-going micro-credit component that has facilitated the formation

of women's groups to access grants and loans from the project to engage in IGA to enhance caregiver households' incomes. Currently the loans are provided directly by the project and loan repayments deposited in group accounts opened for the women's group with the local rural bank. A sustainable revolving fund with the rural banks that can disburse loans to the women is needed. The additional activities that were approved for the final project year will develop a link with the rural bank system and provide further training to the women's groups to understand their rights and responsibilities in working with the banks and effective management of their businesses. These activities will be completed through a consultation with Freedom from Hunger, Ghana which has extensive experience in establishing sustainable micro-credit systems through their trademark Credit Savings with Education program.

2) Heifer, International has extensive experience in developing poultry and small livestock IGA. The additional funds will be used to allow Heifer to expand their activities into our study communities to work with the women's groups in the ENAM project.

Collaborations with Ugandan institutions. Drs. Marquis, Colecraft and Sakyi-Dawson travelled in September to the Iowa State University Sustainable Rural Livelihood's Program (SRL) study district (Kamuli, Uganda) to review the ENAM master's student project and meet the Uganda-based faculty and staff working with the project. Discussions occurred with VEDCO staff as well as faculty at Makerere University to examine intra-continental research and education opportunities for the ENAM project.

1) Joint research collaborations with VEDCO: VEDCO is the lead institution in Uganda for the SRL program that aims to improve rural lives through development focused on agriculture, health, and business. Since June 2006, VEDCO has been providing the local infrastructure (regional office, use of transport vehicles, staff assistance, and community entrance) through which the ENAM-supported master's student, Samuel Oluka, is collecting his data on animal source food use for young children. Oluka's research will be informative to VEDCO on specific issues of interest to them, including

child nutrition and sanitation needs in the district. VEDCO trains and supports community nutrition and health workers and agriculture extension agents throughout the district and is interested in further collaborations with the ENAM project.

Makerere University is an active member of the SRL program in the Kamuli district. The Food Science and Technology department met several times with the visiting faculty to discuss common research interests. In addition, Dr. Charles Muyanja is serving as the local mentor for Samuel Oluka while he is in the field. Discussions were held to explore mechanisms of increasing the student exchange between the University of Ghana and Makerere University with the FST department head as well as with the coordinator of the Regional Universities Forum for Capacity Building in Agriculture (RUFORUM, Professor Adipala Ekwamu). Membership in RUFORUM would allow students to pay local tuition, thus increasing the possibility of student exchange.

Activity Two: Development of community-based activities to improve interventions

Problem Statement and Approach. An important objective for the second year was to support caregivers' IGA to enhance household ASF security. The first step to achieving this was to identify and select (based on established criteria) appropriate caregivers' IGA to support in each intervention community. Participatory processes were used that allowed for caregivers of 2-5 years old children in each intervention community to actively participate in the selection of IGA to be supported by the ENAM project in their communities.

Planned activities. The IGA selection activities included 1) identifying IGA that caregivers of 2-5 year-old children were already doing in the intervention communities; 2) documenting the caregivers' suggestions of other possible IGA for their communities based on four main criteria (access to inputs, access to market, profitability, and potential for the IGA to influence child nutrition through inclusion of ASF in household meals); 3) review of caregivers' IGA (ongoing and suggested) by the project management team and initial selection of

IGA to support based on the four above criteria and potential to show impact on household ASF-food security and children's diets within the time frame of the project; and 4) final selection of IGA by management team following cash flow analysis to access profitability, and assessment of feasibility of new IGA (i.e., those IGA not already being done in the community).

Importance. A major thrust of this project is to improve household income through the support of caregivers' IGA. The process of IGA selection has implications for sustainability and success (with respect to improving incomes). Caregivers' active participation in this process was intended to garner a sense of ownership of the IGA to enhance sustainability. The management review of potential IGA and the evaluation based on cash flow analyses allowed us to select the most viable IGA from among those recommended by caregivers, and enhance the

potential for improved income.

Plans to accomplish activity. The community-based activities were planned to be carried out by the project field officers (one in each intervention region). It was planned that the field officers would be trained in participatory approaches in October 2005 to enhance their capacity to implement the activities. The activities would be initiated in the coastal communities which would serve as the training sites for all of three field officers. It was anticipated that the IGA selection process would be completed in each of the six intervention communities by the end of January 2006.

How the problem model has been modified based on last year's activity. As described below, we had planned to implement different IGA strategies to compare those that provided financial loans (e.g., for traders) to those that provided inputs (e.g., chicks for poultry and eggs) that could then be shared with

Table 1. Primary activities of caregivers engaged in different IGA in the ENAM intervention communities (%)

Caregivers' ongoing IGA	Coastal savannah zone WINNEBA		Forest transitional zone TECHIMAN		Northern savannah zone NAVRONGO	
	Warabebe (rural) (N=28)	Nsuekyire (N=59)	Fiaso (rural) (N=91)	Forikrom (N=68)	Gia (rural) (N=58)	Wuru (N=36)
Farming staples for sale			48.4 (44) ¹	61.8 (42)	12.1 (7)	
Growing/sale of vegetables					15.5 (9)	38.9 (14)
Fish mongering/smoking	7.1 (2)	6.8 (4)			22.4 (13)	
Other fish business ²	78.6 (22)	3.4 (2)				
Petty trading (non-foods)	7.1 (2)	33.9 (20)	20.9 (19)	17.7 (12)	12.1 (7)	11.1 (4)
Selling of foodstuffs		18.6 (11)	13.2 (12)	4.4 (3)	3.4 (2)	28.8 (10)
Selling of cooked food	7.1 (2)	20.3 (12)			10.3 (6)	2.8 (1)
Processing/sale (charcoal, oil, rice parboiling, alcohol)		3.4 (2)	8.8 (8)	2.9 (2)	20.7 (12)	16.7 (6)
Cosmetics/soap making			2.2 (2)			
Service (hairdressing, dress making)		13.6 (8)	6.6 (6)	13.2 (9)	3.4 (2)	2.8 (1)

¹% (n)

²Services (such as assisting with the pulling of the fishing net, or sorting caught fish) provided to fishermen and fishmongers in exchange for fish.

Table 2a. Rankings of IGA based on access to input and markets, profitability and potential to impact child nutrition in Winneba (coastal savannah) area intervention communities.

Rank order	WARABEBA (RURAL)	NSUEKYIRE (SEMI-RURAL)	
	all wealth ranks	low wealth	medium/high wealth
1st	fish smoking	fish smoking	petty trading
2nd	petty trading	trade in foodstuffs	trade in foodstuffs
3rd	trade in foodstuffs	Petty trading (non-food)	fish smoking
4th	poultry		
5th	trade in firewood		

Table 2b. Rankings of IGA based on access to input and markets, profitability and potential to impact child nutrition in Techiman (transitional forest) area intervention communities.

Rank order	FIASO (RURAL)		FORIKROM (SEMI-RURAL)	
	low wealth	medium/high wealth	low wealth	medium/high wealth
1st	farming	petty trading	petty trading	petty trading
2nd	petty trading	farming of staples	farming of staples	farming of staples
3rd	trade in foodstuffs	poultry	gari processing	goat/sheep rearing
4th		soap/cream making	goat/sheep rearing	making tie/dye cloth
5th		trade in foodstuffs	soap/cream making	
6th		fish smoking	poultry	

Table 2c. Rankings of IGA based on access to input and markets, profitability and potential to impact child nutrition in Navrongo (northern savannah) area intervention communities.

Rank order	GIA (RURAL)		WURU (SEMI-RURAL)	
	low wealth	medium/high wealth	low wealth	medium/high wealth
1st	fish smoking	petty trading	trade in foodstuffs	fish mongering
2nd	trade in foodstuff	trade in foodstuffs	fish mongering	trade in foodstuffs
3rd	petty trading	farming of staples	goat/sheep rearing	petty trading
4th		fish smoking	vegetable gardening	goat/sheep rearing
5th			poultry	poultry
6th			brewing of local alcoholic beverage	selling of prepared food
7th				brewing of local alcoholic beverage

new groups. However, the plans for implementing poultry farming had to be abandoned because of the concern for avian flu in Ghana. After reports of avian flu in Nigeria emerged, the sale of day-old chicks was banned by the Ghanaian government. Community groups changed their IGA activities and only financial loans have been implemented to date. For women starting in fish smoking, grants also covered the cost of smoking trays.

Progress. Selection of caregivers IGA was completed by mid-January 2006.

Planned outputs and completion of tasks

1. *Training of project field officers* in participatory approaches was carried out October 24-26, 2005. The training was facilitated by a consultant recommended by Women in Agricultural Development, a subdivision of the Ministry of Food and Agriculture. The training included a one-day didactic session, one-day of field application in one of the intervention communities in Winneba, and one-day of debriefing and evaluation. A final report on the training activities was completed by the field officers and training consultant.

2. *Community activities to identify potential IGA for support.* Between October and December 2005 a series of community meetings were completed with caregivers of 2-5 year-old children in each of the six intervention communities (Warabeba and Nsuekyire in Winneba area; Fiaso and Forikrom in Techiman area; Gia and Wuru in Navrongo area). The outputs of these meetings were a community-specific listing of IGA in which caregivers were already engaged, other possible IGA that caregivers selected for their communities, and caregivers' rankings of the most appropriate IGA for their communities based on the four criteria indicated above. With the exception of the rural coastal savannah community, caregivers were grouped into low and medium/high wealth rank for these meetings. In the rural coastal savannah community, the number of medium/high wealth rank caregivers was relatively small and therefore the caregivers were not divided into groups by economic status.

The number of caregivers who attended the IGA assessment meetings in the different intervention communities ranged from 28 for Warabeba (rural

community in the coastal savannah zone-Winneba area) to 91 for the Fiaso (rural community in the forest transitional zone-Techiman). Caregivers of 2-5 year-old children in the six intervention communities were engaged in 10 different categories of IGA (Table 1). The lowest diversity of IGA was in the rural community of the coastal savannah study area where caregivers were engaged in four different kinds of IGA; the greatest number of different IGA that caregivers were involved in was eight, in the rural community of the northern savannah study area. The only ASF-related IGA that the caregivers attending the meetings were engaged in was fish mongering/smoking and other fish related activities. Almost 80% of caregivers of 2-5 year-old children in the rural coastal savannah community were engaged in fish-related IGA where they received quantities of fish for the services they provided (mainly assisting with pulling the fishing net, sorting out fish after the catch, and or carrying fishing equipment from one point to another). In the forest transitional communities, farming was the most common IGA among the caregivers, followed by petty trading. Interestingly, cultivation and sale of fresh vegetables by caregivers was exclusive to the Northern Savannah communities which experience the lowest frequency of rainfall compared to the other two study areas; the caregivers in these communities were farming along dams in or near their communities.

The caregivers' rankings of IGA they perceived to be the most appropriate IGA for their communities are given in Table 2a-2c. A total of 13 different IGA were recommended and ranked by caregivers of 2-5 year-old children who participated in the meetings in the three study areas. ASF-related IGA that were included were fish mongering/smoking, goat/sheep rearing, and poultry. For the caregiver groups where goat/sheep rearing and poultry were recommended, the caregivers ranked these IGA very high with respect to market, profitability and capacity to influence child nutrition in the home because of the high sale value of the animals. However, these IGA were ranked very low compared to the other suggested IGA for the criteria access to inputs, because they were perceived to require considerably high start-up capital.

3. *ENAM management review and selection of*

caregivers' IGA. The IGA rankings by caregivers were reviewed by the project management team. The initial selection of IGA from among those ranked by the caregivers was: fish mongering/smoking, poultry, trade in firewood, and trade in foodstuffs for the Winneba area communities; poultry and trading for the Techiman area communities; and poultry, fish mongering/smoking, and trading in foodstuffs for the northern savannah communities. Following the cash flow analyses on the initial IGA selections, trade in firewood was dropped as a possible IGA for the Winneba area communities due to high transportation costs to transport firewood from the nearest woodlot farmers to the communities. For poultry, it was decided that the project would support the keeping of chickens for production of eggs. The management team had some concerns about the feasibility of poultry rearing in the coastal savannah communities because of possible lack of access to feed or feed ingredients. Community feasibility assessment for poultry as an IGA was completed for the Winneba communities by the two project co-investigators (Canacoo and Ahunu) with expertise in animal science. Based on the results of this feasibility assessment, it was recommended that poultry be promoted in Nsuekyire (semi-rural community) but not Warabeba. The main reason for the recommendation not to promote poultry in Warabeba was lack of sufficient interest of the caregivers. While poultry was not among the initially ranked IGA in Nsuekyire, further interactions with individual caregivers showed a few were willing to try it if they were provided with the start-up capital required.

Activity Two: Development of community-based activities to improve interventions -- Development of Micro-credit and education intervention packages

Problem statement and approach. Support for IGA to increase caregivers' income security was to be accomplished through provision of micro-credit facilities to caregivers of 2-5 year-old children. This financial support was linked to entrepreneurial training and education on the importance of ASF in children's diets and other child feeding topics.

Planned activities. Prior to implementation of the selected IGA in the intervention communities, we planned to develop a micro-credit package for each selected type of IGA. Planned activities for the entrepreneurial and nutrition education components included development of education modules for use with the caregivers.

Importance. The development of micro-credit packages for the different IGA selected was necessary to appropriately tailor the ENAM project's financial support to specific IGA and also to the different needs of the caregivers. The cash flow analyses for the different IGA types showed differences in costs of inputs and other expenses, as well as differences in expected revenues for different IGA. Caregivers opting for the different IGA, therefore, would require different levels of financial support. Tailoring for individual caregivers was necessary because they had different levels of experience and assets for any given IGA and therefore different support needs. Linking the IGA/micro-credit component with entrepreneurial training provided the opportunity to help caregivers improve their business practices and hence realize the full benefits of the micro-credit support they receive through the project. The essence of providing the caregivers with nutrition-related information and education was to enhance the likelihood that increased income from the IGA would go toward improving household ASF availability and utilization for 2-5 year-old children.

Plans to accomplish activity. The management team planned to review the cash flow analysis for each of the IGA selected and develop a financial support package. The support package would specify: required inputs if any to be provided by the caregivers, grant amount (if any) to be provided to the caregivers, repayable loan amount to be provided by the ENAM project, savings requirements, interest on loans, repayment schedule, and conditions for participation. It was planned that the Ghana-based PI would provide the leadership for the development of the entrepreneurial training component and the program manager would provide the leadership for the nutrition education component. The developed materials would be field tested and the field officers trained in their delivery.

Table 3. Maximum levels of financial support for selected income generation activities for ENAM project intervention caregivers (1US\$ = 9,100 Ghanaian cedis)

A. POULTRY	
Type of financial support: grant and repayable loan	
Prerequisites: Interested caregivers must construct their own chicken coop according to the design provided by the project by the proposed loan disbursement date before they can receive the loan. The project will provide some key items as a 'grant' for construction of the coop.	
The grant and repayable loan components of the support package per person are as follows:	
Support Categories	Monetary Value (Ghanaian ¢)
GRANT	
Wire mesh for coop construction	125,000
Pest/ rodent guard (prepared)	20,000
Roofing sheets for coop construction	160,000
Water trough	12,000
4 bags of feed	560,000
Medication (1 year supply)	100,000
Total grant amount	977,000
REPAYABLE LOAN	
20 point-of-lay chickens	900,000
Maximum disbursement	1,877,000

Progress. Financial support packages were completed for fish smoking, poultry, and trading as IGA for the Winneba area intervention communities. Results from the cash flow analysis for similar activities in the Techiman (trading and poultry) and Navrongo (poultry/guinea fowl, fish smoking, trading) areas were not very different from those obtained for the Winneba area and therefore the support packages developed for the Winneba area were used for the other areas as well. Activities were initiated for the development of entrepreneurial education program for the caregivers and will be completed early in the 3rd year of the project. Nutrition education

B. FISH SMOKING		
Prerequisites: Caregivers interested in the fish smoking business who do not presently have a 'Chorkor-style improved smoking oven' must build one (demonstration provided by the project) before they can receive the loan. The project will provide 10 smoking trays as a grant for interested individuals new to the business or who construct the improved oven for the first time. Those already involved in fish smoking and using the improved type smoker will only receive a repayable loan. The grant and loan products for the 2 categories are as follows:		
Support Categories	Monetary value Ghanaian cedis (¢)	
	New ¹	Veteran
GRANT		
Fish smoking trays (10)	875,000	0
Repayable loan amount	500,000	800,000
Maximum disbursement	1,375,000	800,000
¹ New=caregivers entering into fish smoking business for the first time or those who need to construct new improved smoking oven ; Veteran=caregivers already engaged in fish smoking business using improved smoking oven		

C. Trading	
Prerequisites: None	
Caregivers interested in trading related IGA will receive a repayable loan of up to 500,000 cedis.	
Support categories	Monetary value Ghanaian cedis (¢)
Repayable loan amount	500,000
Maximum disbursement	500,000

modules, including a flip chart developed with the assistance of the Ghana Health Services, were field tested for the nutrition education component.

Planned outputs and completion of tasks:

1. *Support packages.* Financial support packages were completed for the three different IGA selected for the project's intervention communities (Table 3). In addition eligibility requirements and conditions associated with the support packages were specified (Table 4).

2. *Nutrition educational materials.* A nutrition education flip chart was developed and field tested.

Table 4. Eligibility requirements and loan terms for participants in ENAM project interventions in selected communities in the Winneba, Techiman, and Navrongo areas of Ghana

Eligibility requirements:
<ul style="list-style-type: none"> • Must be caregiver of a child 1y 9 mo to <5 y old • Both caregiver and child must be resident in the community • Caregiver must become a member of EMAM project IGA Credit and Savings Association (CSA) to be formed in the community • Must be appraised for a loan by other caregivers in the CSA. • Must fulfill all prerequisites associated with a particular IGA • Caregivers' spouse must agree to her participation • Must agree to all the terms of the assistance package
Micro-credit loan terms
<ul style="list-style-type: none"> • Must form a solidarity group with 3-4 other caregivers to join the ENAM Project CSA (e.g., group of solidarity groups) • IGA financial package represents maximum grant/loan amounts set for each IGA. Actual amount to be received will depend on loan appraisal by other participating caregivers (solidarity group). • The loan cycle will run for a period of 16 weeks (loan amount may be increased during next loan cycle depending on performance) • Interest will not be charged on loans within the first year of loan cycles (for the first 3, 4-month loan cycles) • Save 20% of loan amount by end of loan cycle • Weekly repayment of loan amount and savings. The amount of weekly payments (loan and savings) will be calculated for each caregiver depending on the loan that she amount receives • Weekly meeting attendance for entrepreneurial or nutrition education and loan repayment • Must participate in periodic data collection by ENAM project staff. • New loans for individual caregivers contingent on 100% loan repayment by all CSA members

The flip chart is made up of lesson plans with associated illustrations. The lesson plans were developed by the program manager with input from the ENAM project team members; illustrations for the lessons were done by a consultant from the Ghana Health Services (Health Promotion Unit). The broad topic areas covered by the flip chart are: 1) facts about your 2-5 year-old child; 2) benefits of animal source foods; 3) the balanced plate; and 4) feeding and making the meal time enjoyable. The flip chart was tested in a non-participating community in the Winneba area. All three field officers participated in the Winneba field testing as part of their training. The field officers from the Techiman and Navrongo study areas subsequently tested the flip chart in non-participating communities in their respective areas. The flip chart was revised based on observations made during the field testing. Copies of the final

flip chart were reproduced and distributed to the field officers.

3. *Entrepreneurial education materials.* The entrepreneurial education was initiated with training of the project field officers on entrepreneurial principles using materials adapted from 'Manual for supplementing mothers' income (a solution to child labor)' {a publication from International Centre for Entrepreneurship and Career Development, 1999}. Field officers provided input for the development of entrepreneurial modules based on their own experiences in their field sites. During a project update trip by two of the US-based team members the entrepreneurial education was critically reviewed and broad topic areas for modules were agreed on. Three initial lesson plans based on these modules were developed by the project field supervisor and field tested. We engaged the services of a consultant in September 2006

to complete the development lessons plans based on the defined topics. A draft of the entrepreneurial training manual has been completed.

Activity Two: Development of community-based activities to improve interventions -- Implementation

Problem Statement and Approach. Implementation of the ENAM project interventions to support caregivers was to be accomplished through delivery of the project's support packages to eligible caregivers in groups within the intervention communities.

Planned activities. These included 1) promotion of the fish smoking, poultry and trading as IGA that the project would support in the intervention communities, 2) facilitation of group formation

by interested and eligible caregivers for delivery of the interventions, 3) baseline data collection on specific intervention variables, 4) initiation of the first cycle of credit support activities in each of the communities, and 5) follow-up data collection.

Importance. Most of the planned activities for this section were to enable adequate preparation of the project field officers and caregivers of 2-5 year-old children for effective implementation of the project interventions. In addition, the intervention-specific baseline and follow-up data collection was important to provide a means of measuring improvements in outcomes of interest as a part of the research component of the project.

Plans to accomplish the activity. The project field officers were to be the primary implementers of the project's micro-credit activities and therefore it was planned that they would be trained in key aspects of micro-credit and micro-finance service delivery. Promotion of the selected IGA in the intervention communities would involve: 1) mentoring of interested caregivers by other caregivers within or outside the community who were perceived by community members as successful in the selected IGA and 2) community-wide training for poultry and fish smoking activities. Following these activities the field officers were to facilitate caregiver group formation in the intervention communities. Before initiating the first cycle of micro-credit disbursements it was planned that baseline data on specific aspects of the micro-credit intervention including the education components would be collected. Data collection tools were to be developed based on the interventions and associated research questions specified in the project Work Plan for Year 2. It was planned that the baseline data collection instruments would be used to collect follow-up data every four months. Following completion of the data collection activities the first cycle of financial support activities was to be initiated. It was planned that implementation of intervention activities, including data collection and micro-credit disbursements would be staggered with activities initiating in Winneba, followed by Techiman, and then Navrongo. Micro-credit disbursements were planned to take place in March 2006 for the Winneba sites and May 2006 for the Techiman and Navrongo sites. Record keeping forms were to be

developed for monitoring of the interventions as part of the data collection activities.

Progress. Training of the field officers in micro-credit/micro-credit programming was completed on February 13, 2006. Promotion activities for the caregiver IGA were completed between February 25, 2006 in the Winneba communities and June 29, 2006 in the Navrongo communities. Training for poultry was completed only in the Winneba area because shortly after the Winneba training, avian flu became a concern in Ghana and caregivers were unwilling to pursue poultry as an IGA and the government placed a ban on the importation of day old chicks. As a result of this setback, the project was only able to promote fish smoking and trading (with emphasis on ASF-related activities where possible) as IGA. The initiation of the first cycle of micro-credit disbursements was delayed in all the sites because the group formation processes in the communities took longer than was anticipated. In addition, the field officer for Navrongo resigned and had to be replaced causing further delays in the progress of activities in the intervention communities in the north. The first cycle of micro-credit disbursements were initiated May 16th and 19th, 2006 for the Winneba area study communities; July 6th, 2006 for the Techiman area communities; and August 4th and 5th, 2006 for the Navrongo area study communities.

Planned outputs and completion of tasks. We had originally thought to train MOFA and GHS staff on the assumption that facilitation of the community intervention activities could be incorporated into on-going outreach activities of agriculture extension (MoFA) and nutrition outreach (GHS) workers working in the intervention districts. However this was not possible as the project interventions require intensive ongoing facilitation and monitoring which the agriculture extension and nutrition workers could not add to their own activities. In addition, the extension staff spent less time in the communities than desired because of limited resources. Therefore it was decided that the project field officers (one for each of the 3 regions) would be the primary implementers of the project interventions, and their training needs were considered the priority for year 2.



Figure 1. Community-wide training in fish smoking and the construction of a prototype improved fish smoking oven took place at the Winneba and Navrongo sites. One hundred and forty-three community members participated in the training. Photo by Grace Marquis.



1. *Training field officers for implementation of the project's micro-credit activities:* Training was accomplished through a 3-day workshop facilitated by the credit coordinator for the Upper Manya Krobo Rural Bank who was contracted by the ENAM project. Topics covered during the training were; formation of credit and savings associations (CSA) at the community level; development of group rules and by-laws, adult education principles, and record keeping.

2. *Promotion of project IGA:* Caregivers with 2-5 year-old children who were interested in the selected IGA to be supported in their communities were mentored by successful caregivers in the particular IGA (one mentor for each IGA) in their community through question and answer sessions facilitated by the project field officers in each intervention community. Promotion activities concluded with training in fish smoking (Winneba and Navrongo communities) and poultry keeping (Winneba). The trainings were open to all community members. A prototype fish smoking oven (Figure 1) and a chicken coop were constructed with community members during the trainings for fish smoking and poultry, respectively. A total of 80 adult females and 6 adult males and 53 adult females and 4

adult males participated in the fish smoking activities in the Winneba and Navrongo areas, respectively; 87 females and 7 adult males participated in the poultry training activities in the Winneba area.

3. *Community savings associations (CSA):* In each intervention community, one CSA was set up that was made up of 4-8 solidarity groups of 3-6 caregivers each. After meeting all eligibility requirements for the ENAM project, caregivers' participation was determined by their selection into solidarity groups by other caregivers. The caregivers developed rules and by-laws (including fines for tardiness and absence at meetings) for participation in the CSA and elected leaders (president, secretary, assistant

secretary, treasurer, community organizer, assistant organizer, and porter) for the group.

4. *First 16-week cycle of micro-credit loans:* The loan amount received by each member of a solidarity group was determined by the members of the group through a loan appraisal process facilitated by the project field officers. A total of 136 caregivers of young children received loans. The distribution of wealth rank, selected IGA and loan amounts received by the caregivers in each study locale is summarized in Table 5a.

5. *Monitoring forms for weekly CSA meetings:* Record keeping ledgers and forms were used to monitor caregivers' loan repayments, savings and attendance at weekly education sessions. At the end of the project's second year, the two CSAs in the Winneba had completed the first 16 week loan cycle; attendance and loan repayment performance of the caregivers are provided in Table 5b. Loan repayment rate was 100% for all caregivers in the two CSAs; savings contributions by the rural community CSA members surpassed the 20% (of loan amount) target set by the project, whereas the semi-urban caregivers save < 10%. Further training and education is needed.

6. *Intervention-related baseline data collection:*

Table 5a. Distribution of caregivers' wealth rank, selected IGA and loan amount received

CSA location	# of groups	Caregiver wealth rank			IGA selected		Loan amount in cedis ¹	
		Low	Medium	High	Fish smoking	trading	<500,000	≥500,000
WINNEBA								
Rural	3	4 (31) ²	9 (69)	0 (0)	5 (39)	8 (61)	2 (15.4)	11 (84.6)
Semi-urban	4	9 (60)	6 (40)	0 (0)	3 (20)	12 (80)	4 (26.7)	11 (73.3)
TECHIMAN								
Rural	7	10 (38)	16 (62)	0 (0)	0 (0)	26 (100)	7 (26.9)	19 (73.1)
Semi-urban	8	15 (58)	11 (42)	0 (0)	0 (0)	26 (100)	2 (7.7)	24 (92.3)
NAVRONGO								
Rural	8	20 (63)	11 (34)	1 (3)	10 (42)	14 (58)	32 (100)	0 (0)
Semi-urban	6	19 (79)	4 (17)	1 (4)	17 (53)	15 (47)	24 (100)	0 (0)

¹1US\$=9100 Ghanaian cedis; ²n (%)

Intervention baseline data collection was completed in all sites. Initial results will be presented at the Experimental Biology meetings in Washington D.C. in April 2007.

7. *Preliminary analysis of baseline data.* Data were collected on caregiver/child pairs participating in the ENAM interventions (IP) and two different types of controls: 1) caregiver/child pairs in the intervention communities who did not receive an ENAM project loan (IC) and 2) caregiver/child pairs from the control communities (CC). Effort was made to select control caregivers who matched the IP participants on wealth rank and primary occupation. This was not always possible due to the small sample of caregivers with young children in the communities. Important differences observed between control and intervention caregivers at baseline will be included in the longitudinal analyses. All analyses described below adjusted for small cell numbers with Fisher's Exact Test using SAS software.

Selected demographic characteristics

Winneba (coastal savannah area): None of the three categories of caregivers belonged to 'high' wealth rank households (Table 6a). There were no significant differences in the major occupation of caregivers; At least 66% of the control and intervention caregivers were engaged in ASF related economic activities. In the semi-rural communities,

control caregivers in the intervention community tended to be more likely than the intervention and control community caregivers to be engaged in ASF-related IGA (Table 6b).

Techiman (transitional forest area): Approximately 85% of intervention caregivers in the rural Techiman community were traders compared to 50% or less

Table 5b. First micro-credit loan cycle performance of Winneba area CSA members

Winneba CSA locale	Weekly meeting attendance ¹	Loan repayment	Mean savings (as percent of loan amount taken)
Rural	71.2 ± 5.6, 75	100%	26.0 ± 1.8, 28
Semi-urban	70.5 ± 5.5, 75	100%	7.1 ± 2.5, 2

¹Mean ± SD, median

for the control caregivers ($p < 0.001$; Table 6c). There were no significant differences between the intervention and control caregivers in the selected variables presented for the semi-rural community. A maximum of 20% of caregivers were engaged in ASF-related IGA (Table 6d).

Navrongo (northern savannah area): Over 50% of the caregivers in the rural intervention community were engaged in an ASF-related IGA compared to less than 16% among the control caregivers ($p < 0.0001$; Table 6e). There were no differences in the household wealth rank of the caregivers but more IP caregivers worked in the fish business



Table 6a, 6b. Selected demographic characteristics of caregivers in Winneba: rural (left); semi-rural (right).

Characteristic	Community classification				P-value	Characteristic	Community classification				P-value
	IP (N=13) ¹	IC (N=13)	CC (N=22)				IP (N=15) ¹	IC (N=15)	CC (N=30)		
RELATION TO INDEX CHILD					0.1243	RELATION TO INDEX CHILD					0.8819
Mother	46.15 (6) ²	53.85 (7)	77.27 (17)			93.33 (14) ²	85.71 (12)	83.33 (25)			
Grandmother	30.77 (4)	30.77 (4)	22.73 (5)			6.67 (1)	14.29 (2)	13.33 (4)			
Other relative	23.08 (3)	15.38 (2)	0.00 (0)			0.00 (0)	0.00 (0)	3.33 (1)			
HOUSEHOLD WEALTH RANK					0.0472	HOUSEHOLD WEALTH RANK					0.9039
Low	38.46 (5)	84.62 (11)	50.00 (11)			53.33 (8)	60.00 (9)	53.33 (16)			
Medium	61.54 (8)	15.38 (2)	50.00 (11)			46.67 (7)	40.00 (6)	46.67 (14)			
High	0 (0)	0 (0)	0 (0)								
MAJOR OCCUPATION					0.1892	MAJOR OCCUPATION					0.1220
Crop farming	0.00 (0)	7.69 (1)	0.00 (0)			26.67 (4)	26.67 (4)	46.67 (14)			
Fish business	23.08 (3)	46.15 (6)	50.00 (11)			20.00 (3)	13.33 (2)	0.00 (0)			
Trader	76.92 (10)	38.46 (5)	36.36 (8)			46.67 (7)	53.33 (8)	30.00 (9)			
Other incl.	0.00 (0)	0.00 (0)	9.09 (2)			0.00 (0)	0.00 (0)	10.00 (3)			
Not working	0.00 (0)	7.69 (1)	4.55 (1)			6.67 (1)	6.67 (1)	13.33 (4)			
ASF IGA	76.92 (10)	75.00 (9)	66.67 (14)	0.5035		35.71 (5)	50.00 (7)	15.38 (4)	0.0606		

¹IP=intervention caregiver receiving ENAM loan; IC=control caregiver in intervention community; CC=control caregiver in control community; ² % (n)

Table 6c, 6d. Selected demographic characteristics of caregivers in Techiman: rural (left), semi-rural (right).

Characteristic	Community classification				P-value	Characteristic	Community classification				P-value
	IP ¹	IC	CC				IP ¹	IC	CC		
RELATION TO INDEX CHILD					0.7334	RELATION TO INDEX CHILD					0.5395
Mother	84.62 (22) ²	84.62 (22)	90.38 (47)			100.00(26) ²	92.31 (24)	88.46 (46)			
Grandmother	11.54 (3)	7.69 (2)	3.85 (2)			0.00 (0)	3.85 (1)	3.85 (2)			
Other relative	3.85 (1)	7.69 (2)	5.77 (3)			0.00 (0)	3.85 (1)	7.69 (4)			
HOUSEHOLD WEALTH RANK					<0.0001	HOUSEHOLD WEALTH RANK					0.8503
Low	34.62 (9)	15.38 (4)	57.69 (30)			53.85 (14)	65.38 (17)	59.62 (31)			
Medium	65.38 (17)	84.62 (22)	36.54 (19)			46.15 (12)	34.62 (9)	38.46 (20)			
High	0.00 (0)	0.00 (0)	5.77 (3)			0.00 (0)	0.00 (0)	1.92 (1)			
MAJOR OCCUPATION					<0.0001	MAJOR OCCUPATION					0.7414
Crop farming	7.69 (2)	42.31 (11)	65.38 (34)			38.46 (10)	50.00 (13)	57.69 (30)			
Fish business	0.00 (0)	3.85 (1)	1.92 (1)								
Trader	84.62 (22)	50.00 (13)	23.08 (12)			46.15 (12)	38.46 (10)	30.77 (16)			
Other incl.	7.69 (2)	0.00 (0)	3.85 (2)			11.54 (3)	7.69 (2)	5.77 (3)			
Not working	0.00 (0)	3.85 (1)	5.77 (3)			3.85 (1)	3.85 (1)	5.77 (3)			
ASF IGA	26.92 (7)	12.00 (3)	10.20 (5)	0.2034		20.00 (5)	12.00 (3)	12.24 (6)	0.6567		

¹IP=intervention caregiver receiving ENAM loan;

IC=control caregiver in intervention community; CC=control caregiver in control community; ² % (n)

Table 6e, 6f. Selected demographic characteristics of caregivers in Navrongo: rural (left), semi-rural (right).

Characteristic	Community classification				P-value	Characteristic	Community classification				P-value
	IP ¹	IC	CC	P-value			IP ¹	IC	CC	P-value	
RELATION TO INDEX CHILD					0.8583	RELATION TO INDEX CHILD					0.2811
Mother	93.94 (31) ²	100.00 (30)	93.22 (55)			Mother	91.67 (22) ²	77.27 (17)	86.36 (38)		
Grandmother	3.03 (1)	0.00 (0)	5.08 (3)			Grandmother	4.17 (1)	22.73 (5)	11.36 (5)		
Other relative	3.03 (1)	0.00 (0)	1.69 (1)			Other relative	4.17 (1)	0.00 (0)	2.27 (1)		
HOUSEHOLD WEALTH RANK					0.2166	HOUSEHOLD WEALTH RANK					0.8471
Low	69.70 (23)	90.00 (27)	78.69 (48)			Low	75.00 (18)	86.36 (19)	77.27 (34)		
Medium	30.30 (10)	10.00 (3)	19.67 (12)			Medium	16.67 (4)	9.09 (2)	18.18 (8)		
High	0.00 (0)	0.00 (0)	1.64 (1)			High	8.33 (2)	4.55 (1)	4.55 (2)		
MAJOR OCCUPATION					<0.0001	MAJOR OCCUPATION					0.0223
Crop farming	21.21 (7)	46.67 (14)	81.97 (50)			Crop farming	45.83 (11)	27.27 (6)	29.55 (13)		
Fish business	39.39 (13)	6.67 (2)	0.00 (0)			Fish business	8.33 (2)	9.09 (2)	2.27 (1)		
Trader	33.33 (11)	30.00 (9)	11.48 (7)			Trader	45.83 (11)	59.09 (13)	36.36 (16)		
Other incl.	0.00 (0)	3.33 (1)	1.64 (1)			Other	0.00 (0)	0.00 (0)	18.18 (8)		
Not working	6.06 (2)	13.33 (4)	4.92 (3)			Not working	0.00 (0)	4.55 (1)	13.64 (6)		
ASF IGA	54.84 (17)	15.38 (4)	5.17 (3)	<0.0001		ASF IGA	25.00 (6)	14.29 (3)	18.42 (7)	0.6808	

¹IP=intervention caregiver receiving ENAM loan; IC=control caregiver in intervention community; CC=control caregiver in control community; ² % (n)

($p < 0.0001$). Among semi-rural caregivers, there were no significant differences between the caregivers with respect to the relationship of the caregiver to the index child, household wealth rank and whether or not the caregiver was engaged in an ASF-related IGA. There were significant differences in the major occupation of the caregivers.

Food Security. Caregivers' responses to food security questionnaire items are summarized in Tables 7a-7f.

Winneba: In both the rural and semi-rural communities there were no significant differences between the caregivers with respect to the two ASF-related food security items (Tables 7a and 7b). At least 54% and 57% of rural and semi-rural caregivers, respectively indicated that they had sometimes or often been unable to have enough ASF in the family meals for their 2-5 year-old child to get some on his/her plate in the last month

Techiman: Approximately 30% to 45% of the rural and semi-rural caregivers in Techiman had been often or sometimes unable to include any ASF in the family meals they ate in the last month (Tables 7c and

7d). In the semi-rural communities, 2-5 year-old children of intervention caregivers were more likely to have eaten less meals than usual sometime during the past month compared to the two categories of control caregivers (42.3% vs 11.5% and 30.8%; $P = 0.0454$).

Navrongo: In both rural and semi-rural communities there were no significant differences between caregivers with respect to the two ASF-related food security questions (Tables 7e and 7f). At least 78% of caregivers in the Navrongo area communities had sometimes or often been unable to include ASF in their family's meals in the last month.

Food/ASF Expenditures.

Winneba: At least 90% of the rural and semi-rural caregivers had purchased food ingredients for cooking in the week preceding the interview and the majority (at least 92%) had used ASF to prepare meal(s) in the last week (Tables 8a and 8b). There were no significant differences between the caregivers (in both rural and semi-rural communities) in the total amounts of money spent on ASF and the

Table 7a. Household Food/ASF Security: rural communities in Winneba area.

Food security statement	Caregiver classification			
	IP ¹ (N=13)	IC (N=13)	CC (N=22)	P-value
IN THE LAST MONTH WE..				
couldn't prepare the kind of foods we will want to eat for good health.				
<i>Often / Sometimes true</i>	84.6 (11) ²	100.0(13)	77.3(17)	
<i>Never true</i>	15.4 (2)	0.0(0)	22.7 (5)	
<i>Refused to answer/ does not know</i>	0.0 (0)	0.0 (0)	0.0 (0)	0.2002
have been worried that our food would run out before we get more				
<i>Often / Sometimes true</i>	92.3 (12)	92.3(12)	81.8(18)	
<i>Never true</i>	7.7 (1)	7.7(1)	18.2(4)	0.6310
have been unable to feed our child the kinds of food they need to be healthy				
<i>Often / Sometimes true</i>	100.0 (13)	92.3 (12)	81.8 (18)	
<i>Never true</i>	0.0 (0)	7.7 (1)	18.2 (4)	0.3559
<i>Refused to answer/ does not know</i>				
have been unable to feed our child enough to satisfy his/her hunger				
<i>Often / Sometimes true</i>	76.9(10)	84.6(11)	45.5(10)	
<i>Never true</i>	23.1(3)	7.7(1)	54.5(12)	
<i>Refused to answer/ does not know</i>	0.0(0)	7.7(1)	0.0(0)	0.0136
have been unable to have enough ASF in the household meals for our old child to get some on his/her plate				
<i>Often / Sometimes true</i>	61.5(8)	76.9(10)	54.6(12)	
<i>Never true</i>	30.8(4)	23.1(3)	45.5(10)	
<i>Refused to answer/ does not know</i>	7.7(1)	0.0(0)	0.0(0)	0.3371
have been unable to have any ASF in the household meals we ate				
<i>Often / Sometimes true</i>	23.1(3)	23.1(3)	50.0(11)	
<i>Never true</i>	76.9(10)	76.9(10)	50.0(11)	0.1459
<i>Refused to answer/ does not know</i>				
IN THE LAST MONTH adults in household reduced or skipped meals	30.8(4)	53.9 (7)	54.6 (12)	0.3496 ³
<i>Almost every day</i>	0.0 (0)	0.0 (0)	0.0 (0)	
<i>2-3 days a week</i>	0.0(0)	14.3(1)	25(3)	
<i>Once a week or less</i>	75.0(3)	85.7(6)	41.7(5)	
<i>don't know/refused to answer</i>	25(1)	0.0(0)	33.3(4)	0.2992 ⁴
IN THE LAST MONTH child sometimes ate less meals than usual	61.5(8)	84.6(11)	50.0(11)	0.1551 ³
<i>Almost every day</i>	0.0(0)	0.0(0)	9.1(1)	
<i>2-3 days a week</i>	0.0(0)	0.0(0)	36.4(4)	
<i>once a week or less</i>	62.5(5)	90.9(10)	36.4(4)	
<i>don't know/refused to answer</i>	37.5(3)	9.1(1)	18.2(2)	0.0270 ⁴

¹IP=intervention caregiver receiving ENAM loan; IC=control caregiver in intervention community; CC=control caregiver in control community; ² % (n); ³ P-value is in reference to reducing food or skipping meals; ⁴ P-value is in reference to those who said 'yes' for the skipped/reduced meals, how often did it happened

Table 7b. Household Food/ASF Security: semi-rural communities in Winneba area.

Food security statement	Caregiver classification			
	IP ¹ (N=16)	IC (N=14)	CC (N=30)	P-value
IN THE LAST MONTH WE...				
couldn't prepare the kind of foods we will want to eat for good health.				
<i>Often / Sometimes true</i>	87.5 (14) ²	78.6 (11)	86.7 (26)	
<i>Never true</i>	12.5 (2)	21.4 (3)	13.3 (4)	
<i>Refused to answer/ does not know</i>	0.0 (0)	0.0 (0)	0.0 (0)	0.8003
have been worried that our food would run out before we get more				
<i>Often / Sometimes true</i>	87.5(14)	71.4(10)	100.0(30)	
<i>Never true</i>	12.5(2)	28.6(4)	0.0(0)	0.0057
<i>Refused to answer/ does not know</i>	0.0 (0)	0.0(0)	0.0(0)	
have been unable to feed our child the kinds of food they need to be healthy				
<i>Often / Sometimes true</i>	62.5(10)	71.4(10)	90.0(27)	
<i>Never true</i>	31.3(5)	28.6(4)	10.0(3)	
<i>Refused to answer/ does not know</i>	6.3(1)	0.0(0)	0.0(0)	0.0926
have been unable to feed our child enough to satisfy his/her hunger				
<i>Often / Sometimes true</i>	56.3(9)	42.9(6)	80(24)	
<i>Never true</i>	43.8(7)	57.1(8)	16.7(5)	
<i>Refused to answer/ does not know</i>	0.0(0)	0.0(0)	3.3(1)	0.0306
have been unable to have enough ASF in the household meals for our old child to get some on his/her plate				
<i>Often / Sometimes true</i>	62.5(10)	57.1(8)	83.3(25)	
<i>Never true</i>	37.5(6)	42.9(6)	16.7(5)	
<i>Refused to answer/ does not know</i>	0.0 (0)	0.0 (0)	0.0 (0)	0.1306
have been unable to have any ASF in the household meals we ate				
<i>Often / Sometimes true</i>	37.5(6)	21.4(3)	46.7(14)	
<i>Never true</i>	62.5(10)	78.6(11)	53.3(14)	0.2755
<i>Refused to answer/ does not know</i>	0.0 (0)	0.0 (0)	0.0 (0)	
In the last month adults in household reduced or skipped meals	68.8(11)	42.9(6)	83.3(25)	0.0245 ³
<i>almost every day</i>	9.1(1)	0.0(0)	0.0(0)	
<i>2-3 days a week</i>	0.0(0)	0.0(0)	8.0(2)	
<i>once a week or less</i>	72.7(8)	83.3(5)	64.0(16)	
<i>don't know/refused to answer</i>	18.2(2)	16.7(1)	28.0(7)	0.7407 ⁴
In the last month child sometimes ate less meals than usual	56.3(9)	57.1(8)	80.0(24)	0.1481 ³
<i>almost every day</i>	11.1(1)	0.0(0)	0.0(0)	
<i>2-3 days a week</i>	0.0(0)	0.0(0)	8.3(2)	
<i>once a week or less</i>	77.8(7)	100.0(8)	66.7(16)	
<i>don't know/refused to answer</i>	11.1(1)	0.0(0)	25(6)	0.3105 ⁴

¹IP=intervention caregiver receiving ENAM loan; IC=control caregiver in intervention community; CC=control caregiver in control community; ² % (n); ³ P-value is in reference to reducing food or skipping meals; ⁴ P-value is in reference to those who said 'yes' for the skipped/reduced meals, how often did it happened



Table 7c. Household Food/ASF Security: rural communities in Techiman area.

Food security statement	Caregiver classification			
	IP ¹ (N=26)	IC (N=26)	CC (N=52)	P-value
IN THE LAST MONTH WE...				
couldn't prepare the kind of foods we will want to eat for good health.				
<i>Often / Sometimes true</i>	53.9(14) ²	61.5(16)	51.9(27)	
<i>Never true</i>	46.2(12)	38.5(10)	48.1(25)	
<i>Refused to answer/ does not know</i>	0.0 (0)	0.0 (0)	0.0 (0)	0.7597
have been worried that our food would run out before we get more				
<i>Often / Sometimes true</i>	56.7(15)	42.3(11)	46.2(24)	
<i>Never true</i>	42.3(11)	57.7(15)	53.9(28)	
<i>Refused to answer/ does not know</i>	0.0 (0)	0.0 (0)	0.0 (0)	0.4999
have been unable to feed our child the kinds of food they need to be healthy				
<i>Often / Sometimes true</i>	69.2(8)	65.4(17)	53.9(28)	
<i>Never true</i>	30.8(8)	34.6(9)	46.2(24)	
<i>Refused to answer/ does not know</i>	0.0 (0)	0.0 (0)	0.0 (0)	0.3582
have been unable to feed our child enough to satisfy his/her hunger				
<i>Often / Sometimes true</i>	26.9(7)	46.2(12)	32.7(17)	
<i>Never true</i>	73.1(19)	50.0(13)	67.3(35)	
<i>Refused to answer/ does not know</i>	0.0(0)	3.9(1)	0.0(0)	0.2046
have been unable to have enough ASF in the household meals for our old child to get some on his/her plate				
<i>Often / Sometimes true</i>	50.0(13)	61.54(16)	61.5(32)	
<i>Never true</i>	50.0(13)	38.5(10)	38.5(20)	0.5855
<i>Refused to answer/ does not know</i>	0.0 (0)	0.0 (0)	0.0 (0)	
have been unable to have any ASF in the household meals we ate				
<i>Often / Sometimes true</i>	38.5 (10)	46.1 (12)	36.5 (19)	
<i>Never true</i>	61.5 (16)	53.9 (14)	63.5 (33)	0.7102
<i>Refused to answer/ does not know</i>	0.0(0)	0.0(0)	0.0 (0)	
In the last month adults in household reduced or skipped meals	42.3(11)	50.0(13)	53.9(28)	0.6303 ³
<i>almost every day</i>	0.0(0)	7.7(1)	7.1(2)	
<i>2-3 days a week</i>	18.2(2)	7.7(1)	10.7(3)	
<i>once a week or less</i>	45.5(5)	53.9(7)	46.4(13)	
<i>don't know/refused to answer</i>	36.4(4)	30.7(4)	35.7(10)	0.9927 ⁴
In the last month child sometimes ate less meals than usual	19.2(5)	26.9(7)	38.5(20)	0.1969 ³
<i>almost every day</i>	0.0(0)	0.0(0)	10.0(2)	
<i>2-3 days a week</i>	20.0(1)	14.3(1)	15.0(3)	
<i>once a week or less</i>	20.0(1)	42.9(3)	30.0(6)	
<i>don't know/refused to answer</i>	60.0(3)	42.9(3)	45.0(9)	0.9894 ⁴

¹IP=intervention caregiver receiving ENAM loan; IC=control caregiver in intervention community; CC=control caregiver in control community; ² % (n); ³ P-value is in reference to reducing food or skipping meals; ⁴ P-value is in reference to those who said 'yes' for the skipped/reduced meals, how often did it happened



Table 7d. Household Food/ASF Security: rural communities in Techiman area.

Food security statement	Caregiver classification			
	IP ¹ (N=26)	IC (N=26)	CC (N=52)	P-value
IN THE LAST MONTH WE...				
couldn't prepare the kind of foods we will want to eat for good health.				
<i>Often / Sometimes true</i>	65.4 (17)	61.5 (16)	46.2 (24)	
<i>Never true</i>	34.6 (9)	34.6 (9)	51.92 (27)	
<i>Refused to answer/ does not know</i>	0.0 (0) ²	3.9 (1)	1.9 (1)	0.3238
have been worried that our food would run out before we get more				
<i>Often / Sometimes true</i>	61.5 (16)	38.5 (10)	65.4 (34)	
<i>Never true</i>	38.5 (10)	61.5 (16)	34.6(18)	0.0686
<i>Refused to answer/ does not know</i>	0.0 (0)	0.0 (0)	0.0 (0)	
have been unable to feed our child the kinds of food they need to be healthy				
<i>Often / Sometimes true</i>	53.9 (14)	50.0(13)	63.5(33)	
<i>Never true</i>	46.2(12)	50.0(13)	34.6(18)	
<i>Refused to answer/ does not know</i>	0.0(0)	0.0(0)	1.9(1)	0.6412
have been unable to feed our child enough to satisfy his/her hunger				
<i>Often / Sometimes true</i>	26.9 (7)	19.2 (5)	38.5 (20)	
<i>Never true</i>	73.1 (19)	80.8 (21)	61.5 (32)	0.1969
<i>Refused to answer/ does not know</i>	0.0 (0)	0.0 (0)	0.0 (0)	
have been unable to have enough ASF in the household meals for our old child to get some on his/her plate				
<i>Often / Sometimes true</i>	56.0 (14)	46.2 (12)	53.9 (28)	
<i>Never true</i>	44.0 (11)	53.9 (14)	46.2 (24)	0.7482
<i>Refused to answer/ does not know</i>				
have been unable to have any ASF in the household meals we ate	30.8 (8)	38.5 (10)	42.3 (22)	
<i>Often / Sometimes true</i>	69.2 (18)	61.5 (16)	55.8 (29)	
<i>Never true</i>	0.0 (0)	0.0 (0)	1.9 (1)	0.7922
<i>Refused to answer/ does not know</i>	53.9 (14)	19.2 (5)	51.9 (27)	0.01223
In the last month adults in household reduced or skipped meals	7.1(1)	0.0(0)	0.0(0)	
<i>almost every day</i>	0.0 (0)	20.0 (1)	11.1(3)	
<i>2-3 days a week</i>	50.0 (7)	80.0(4)	62.9 (17)	
<i>once a week or less</i>	42.9 (6)	0.0(0)	25.9 (7)	0.20894
<i>don't know/refused to answer</i>	42.3 (11)	11.5 (3)	30.8 (16)	0.04543
In the last month child sometimes ate less meals than usual	9.1 (1)	0.0 (0)	0.0 (0)	
<i>almost every day</i>	18.2 (2)	33.3(1)	0.0 (0)	
<i>2-3 days a week</i>	45.4 (5)	66.7(2)	81.2 (13)	
<i>once a week or less</i>	27.3 (3)	0.0 (0)	18.8 (3)	0.14834
<i>don't know/refused to answer</i>	16.7(3)	42.9(6)	16.7(7)	0.11604

¹IP=intervention caregiver receiving ENAM loan; IC=control caregiver in intervention community; CC=control caregiver in control community; ² % (n); ³ P-value is in reference to reducing food or skipping meals; ⁴ P-value is in reference to those who said 'yes' for the skipped/reduced meals, how often did it happened



Table 7e. Household Food/ASF Security: rural communities in Navrongo area.

Food security statement	Caregiver classification			
	IP ¹ (N=33)	IC (N=30)	CC (N=61)	P-value
IN THE LAST MONTH WE...				
couldn't prepare the kind of foods we will want to eat for good health.				
<i>Often / Sometimes true</i>	84.9(28) 2	90.0(27)	98.4(60)	
<i>Never true</i>	15.2(5)	10.0(3)	1.6(1)	
<i>Refused to answer/ does not know</i>	0.0 (0)	0.0 (0)	0.0 (0)	0.0224
have been worried that our food would run out before we get more				
<i>Often / Sometimes true</i>	90.9 (30)	100.0 (30)	96.7 (59)	
<i>Never true</i>	9.1 (3)	0.0 (0)	3.3 (2)	
<i>Refused to answer/ does not know</i>	0.0 (0)	0.0 (0)	0.0 (0)	0.2341
have been unable to feed our child the kinds of food they need to be healthy				
<i>Often / Sometimes true</i>	84.9 (28)	96.7 (29)	98.4 (60)	
<i>Never true</i>	12.1(4)	3.3 (1)	1.6 (1)	
<i>Refused to answer/ does not know</i>	3.0 (1)	0.0 (0)	0.0 (0)	0.0511
have been unable to feed our child enough to satisfy his/her hunger				
<i>Often / Sometimes true</i>	93.9(31)	83.3(25)	88.5(54)	
<i>Never true</i>	6.1(2)	16.7(5)	11.5(7)	
<i>Refused to answer/ does not know</i>	0.0 (0)	0.0 (0)	0.0 (0)	0.3991
have been unable to have enough ASF in the household meals for our old child to get some on his/her plate				
<i>Often / Sometimes true</i>	93.9(31)	93.3(28)	95.1(58)	
<i>Never true</i>	6.1(2)	3.3(1)	4.9(3)	0.7104
<i>Refused to answer/ does not know</i>	0.0(0)	3.3(1)	0.0(0)	
have been unable to have any ASF in the household meals we ate				
<i>Often / Sometimes true</i>	87.9 (29)	90.0 (27)	78.7 (48)	
<i>Never true</i>	12.1 (4)	10.0 (3)	19.7 (12)	
<i>Refused to answer/ does not know</i>	0 (0)	0 (0)	1.6 (1)	0.6386
In the last month adults in household reduced or skipped meals	69.7(23)	66.7(20)	78.7(48)	0.4062 ³
<i>almost every day</i>	4.4(1)	10.0(2)	2.1()	
<i>2-3 days a week</i>	4.4(1)	0.0(0)	6.25(3)	
<i>once a week or less</i>	65.2(15)	25.0(5)	62.5(30)	
<i>don't know/refused to answer</i>	26.1(6)	65.0(13)	29.2(14)	0.0191 ⁴
In the last month child sometimes ate less meals than usual	54.5(18)	46.7(14)	68.9(42)	0.1000 ³
<i>almost every day</i>	5.6(1)	14.3(2)	2.4(1)	
<i>2-3 days a week</i>	0.0(0)	0.0(0)	4.8(2)	
<i>once a week or less</i>	77.8(14)	42.9(6)	76.2(32)	
<i>don't know/refused to answer</i>	16.7(3)	42.9(6)	16.7(7)	0.1160 ⁴

¹IP=intervention caregiver receiving ENAM loan; IC=control caregiver in intervention community; CC=control caregiver in control community; ² % (n); ³ P-value is in reference to reducing food or skipping meals; ⁴ P-value is in reference to those who said 'yes' for the skipped/reduced meals, how often did it happened



Table 7f. Household Food/ASF Security: semi-rural communities in Navrongo area.

Food security statement	Caregiver classification			
	IP ¹ (N=24)	IC (N=22)	CC (N=44)	P-value
IN THE LAST MONTH WE...				
couldn't prepare the kind of foods we will want to eat for good health.				
<i>Often / Sometimes true</i>	91.7 (22) 2	81.8 (18)	100.0 (44)	
<i>Never true</i>	8.3 (2)	18.2 (4)	0.0 (0)	
<i>Refused to answer/ does not know</i>	0.0 (0)	0.0 (0)	0.0 (0)	0.0110
have been worried that our food would run out before we get more				
<i>Often / Sometimes true</i>	100.0 (24)	95.5 (21)	100.0 (44)	
<i>Never true</i>	0.0 (0)	4.5 (1)	0.0 (0)	
<i>Refused to answer/ does not know</i>	0 (0)	0 (0)	0 (0)	0.2444
have been unable to feed our child the kinds of food they need to be healthy				
<i>Often / Sometimes true</i>	95.8 (23)	86.4 (19)	95.5 (42)	
<i>Never true</i>	4.2 (1)	13.6 (3)	4.5 (2)	
<i>Refused to answer/ does not know</i>	0 (0)	0 (0)	0 (0)	0.4131
have been unable to feed our child enough to satisfy his/her hunger				
<i>Often / Sometimes true</i>	91.6 (22)	86.4 (19)	93.2 (41)	
<i>Never true</i>	8.3 (2)	13.6 (3)	4.6 (2)	
<i>Refused to answer/ does not know</i>	0.0 (0)	0 (0)	2.2 (1)	0.5901
have been unable to have enough ASF in the household meals for our old child to get some on his/her plate				
<i>Often / Sometimes true</i>	95.8(23)	95.5(21)	97.7(43)	
<i>Never true</i>	4.2(1)	0.0(0)	2.3(1)	
<i>Refused to answer/ does not know</i>	0.0(0)	0.0(0)	0 (0)	0.5714
have been unable to have any ASF in the household meals we ate				
<i>Often / Sometimes true</i>	91.7(22)	81.8(18)	84.1(37)	
<i>Never true</i>	8.3(2)	18.2(4)	15.9(7)	
<i>Refused to answer/ does not know</i>	0.0 (0)	0.0 (0)	0.0 (0)	0.6344
In the last month adults in household reduced or skipped meals	58.3 (14)	63.6 (14)	81.8 (36)	0.08373
<i>almost every day</i>	7.1 (1)	0 (0)	11.1 (4)	
<i>2-3 days a week</i>	0.0(0)	7.1(1)	2.8(1)	
<i>once a week or less</i>	42.9(6)	50.0(7)	52.8(19)	
<i>don't know/refused to answer</i>	50.0(7)	42.9(6)	33.3(12)	0.74104
In the last month child sometimes ate less meals than usual	41.7(10)	50.0(11)	61.4(27)	0.27933
<i>almost every day</i>	10.0(1)	9.1(1)	7.4(2)	
<i>2-3 days a week</i>	10.0(1)	0.0(0)	7.4(2)	
<i>once a week or less</i>	50.0(5)	72.7(8)	51.9(14)	
<i>don't know/refused to answer</i>	30.0(3)	18.2(2)	33.3(9)	0.6774

¹IP=intervention caregiver receiving ENAM loan; IC=control caregiver in intervention community; CC=control caregiver in control community; ² % (n); ³ P-value is in reference to reducing food or skipping meals; ⁴ P-value is in reference to those who said 'yes' for the skipped/reduced meals, how often did it happened



Table 8a. Caregivers' food/ASF expenditures in the last week: rural community in Winneba.

Variable	Community classification			
	IP ¹ (N=13)	IC (N=13)	CC (N=22)	P-value
Purchased ingredients for cooking	100 (13) ²	100 (13)	90.9 (20)	0.1238
Used ASF to cook	100 (13)	100 (13)	95.0 (19)	0.3089
SOURCE OF ASF USED				0.6278
Purchased	76.9 (10)	76.9 (10)	78.9 (15)	
Home produced	15.4 (2)	23.1 (3)	10.5 (2)	
Gift	7.69 (1)	0.00 (0)	0.00 (0)	
Other	0.00 (0)	0.00 (0)	10.5 (2)	
Total food expenditures (Ghanaian ₵)	37778 ±264713	30000 ±13123	40667 ±16373	0.4204
ASF expenditures (Ghanaian ₵)	15667 ±12062	13200 ±7466	19167 ±9350	0.3622
% expenditures on ASF	40 ± 13	44 ± 15	47 ± 15	0.5456

Table 8b. Caregivers' food/ASF expenditures in the last week: semi-rural communities in Winneba.

Variable	Community classification			
	IP ¹ (N=13)	IC (N=13)	CC (N=22)	P-value
Purchased ingredients for cooking	93.3 (14) 2	100 (15)	90.0 (27)	0.5571
Used ASF to cook	92.7 (13)	100.00 (15)	100.00 (27)	0.1346
SOURCE OF ASF USED				0.5810
Purchased	92.3 (12)	93.3 (14)	96.3 (26)	
Home produced	7.69 (1)	6.67 (1)	3.70 (1)	
Gift				
Other				
Total food expenditures (Ghanaian ₵)	34417 ±272613	33667 ± 17696	27880 ± 28127	0.7052
ASF expenditures (Ghanaian ₵)	15417 ±12258	10750 ±4827	10480 ±10847	0.3613
% expenditures on ASF	44 ± 12	34 ± 10	38 ± 17	0.2480

¹IP=intervention caregiver receiving ENAM loan; IC=control caregiver in intervention community; CC=control caregiver in control community; ²% (n); ³mean ± standard deviation

proportion of total food expenditures that was allocated to ASF in the past week. Among rural caregivers, nearly 80% of ASF used for cooking in the past week was purchased; among semi-rural caregivers more than 90% of ASF used in the past week for preparing home meals was purchased.

Techiman: Caregivers in both rural and semi-rural communities had similar food expenditure patterns (Tables 8c and 8d). However, in the semi-rural CC communities the percentage of total food expenditures that was used for ASF tended to be lower than that for the other two categories of caregivers (32.83 ± 16.99 vs. 43.08 ± 22.25 and

44.71 ± 17.52; P=0.052).

Navrongo: In the rural communities, caregivers in the control community were less likely to have used ASF in meals they cooked for the family in the last week; these control caregivers also spent less money than the intervention caregivers on ASF (Tables 8e and 8f). Approximately 36% of ASF used by intervention caregivers was home produced compared to less than 16% for the control caregivers. Among the semi-rural caregivers, the CC caregivers tended to have used a greater proportion of their total food expenditures for ASF.

Table 8c. Caregivers' food/ASF expenditures in the last week: rural community in Techiman.

Variable	Community classification			
	IP ¹ (N=26)	IC (N=26)	CC (N=52)	P-value
Purchased ingredients for cooking	88.5 (23) ²	92.3 (24)	96.2 (50)	0.1964
Used ASF to cook	95.65 (22)	95.83 (23)	98.00 (49)	0.5532
SOURCE OF ASF USED				0.3849
Purchased	100.00 (22)	100.00 (23)	97.96 (48)	
Home produced	0.00 (0)	0.00 (0)	2.04 (1)	
Gift				
Other				
Total food expenditures (Ghanaian ₵)	38895 ±45006 ³	34773 ±61358	27000 ±31998	0.5757
ASF expenditures (Ghanaian ₵)	16000 ±30328	9318 ±6658	9233 ±10668	0.3022
% expenditures on ASF	43 ± 21	47 ± 20	41 ± 20	0.4556

Table 8d. Caregivers' food/ASF expenditures in the last week: semi-rural communities in Techiman.

Variable	Community classification			
	IP ¹ (N=26)	IC (N=26)	CC (N=52)	P-value
Purchased ingredients for cooking	100 (26) ²	96.2 (25)	92.3 (48)	0.1002
Used ASF to cook	100 (26)	100 (25)	100 (48)	
SOURCE OF ASF USED				0.2183
Purchased	88.46 (23)	92.00 (23)	97.92 (47)	
Home produced	11.54 (3)	4.00 (1)	2.08 (1)	
Gift				
Other	0 (0)	4.0 (1)	0 (0)	
Total food expenditures (Ghanaian ₵)	33722 ±24046 ³	30905 ±15192	33447 ±85101	0.9873
ASF expenditures (Ghanaian ₵)	12944 ±10143	8952 ±5652	9413 ±9609	0.3004
% expenditures on ASF	43 ±22ab	33 ± 17a	45 ±18b	0.0520

Table 8e. Caregivers' food/ASF expenditures in the last week: rural community in Navrongo.

Variable	Community classification			
	IP ¹ (N=33)	IC (N=30)	CC (N=61)	P-value
Purchased ingredients for cooking	100.00 (33) ²	100.00 (30)	96.2 (59)	0.1950
Used ASF to cook	100.00 (33)	96.67 (29)	89.83 (53)	0.0379
SOURCE OF ASF USED				0.0088
Purchased	60.61 (20)	89.66 (26)	84.91 (45)	
Home produced	36.36 (12)	10.34 (3)	15.09 (8)	
Gift	3.03 (1)	0.00 (0)	0.00 (0)	
Other				
Total food expenditures (Ghanaian ₵)	20211 ±11272 ³	18120 ±12098	17872 ±12042	0.7589
ASF expenditures (Ghanaian ₵)	7579 ±4260a	5480 ±4529ab	4731 ±3570b	0.0461
% expenditures on ASF	39 ± 14	31 ± 13	32 ±11	0.1925

¹IP=intervention caregiver receiving ENAM loan; IC=control caregiver in intervention community; CC=control caregiver in control community; ² % (n); ³ mean ± standard deviation



Activity Three: Training

Problem Statement and Approach. The problem model for constraints to ASF in children's diets in Ghana being used by the ENAM project underscores the need for integrated and multidisciplinary approaches to effectively address the issues and hence the need for professionals with training in these approaches. Therefore, providing graduate students with research opportunities to address ASF-related issues within a multidisciplinary framework was an important capacity building objective of the project.

Planned activities: Continued support for the Ugandan master's student. Identify University of Ghana master's students in Agriculture or Nutrition to support in their thesis research work.

Importance: The student research activities in Uganda provides an opportunity to test the problem model for constraints to ASF in children's diets in Ghana in another African country and assess the potential utility of the model as a framework for addressing ASF-related issues in the Africa region. It also is a mechanism to establish links between institutions in Ghana and Uganda. The involvement of students (Ugandan and Ghanaian) in the project's integrated research activities and the provision of opportunities to interact with the multidisciplinary teams are important to their

professional development and capacity to effectively identify and address nutrition and agriculture issues in communities.

Plans to accomplish activity: It was planned that the Ugandan student supported by the project would complete his coursework, write a proposal for his master's thesis research to assess constraints to ASF in children's diets in Uganda, and return to Uganda to initiate his research activities in communities where the Sustainable Rural Livelihoods program (collaboration between Iowa State University, Makerere University, and the agriculture-based NGO, VEDCO) is active. In addition, the project planned to support University of Ghana (at Legon) agriculture and nutrition master's-level students interested in conducting field research on ASF-related topics in the ENAM project communities for their thesis research. The project would provide support (through student advising, financial and logistical support research and a small stipend) for the students to develop proposals and complete their field data collection.

Progress. Activities related to the Ugandan student were completed as scheduled. Field research of Ghanaian students from the Department of Nutrition and Food Science was supported over this past year through project funds.

Planned outputs and completion of tasks:

Table 8f. Caregivers' food/ASF expenditures in the last week: semi-rural communities in Navrongo.

Variable	Community classification			
	IP ¹ (N=33)	IC (N=30)	CC (N=61)	P-value
Purchased ingredients for cooking	100.00 (24) ²	100.00 (22)	100.00 (44)	
Used ASF to cook	100.00 (24)	90.91 (20)	86.36 (38)	0.0642
SOURCE OF ASF USED				0.9433
Purchased	83.33 (20)	85.00 (17)	86.84 (33)	
Home produced	16.67 (4)	15.00 (3)	10.53 (4)	
Gift	0.00 (0)	0.00 (0)	2.63 (1)	
Other				
Total food expenditures (Ghanaian ₵)	27938 ± 195843,ab	33750 ± 17748a	19219 ± 11828b	0.0097
ASF expenditures (Ghanaian ₵)	6250 ± 3606	6750 ± 2769	6210 ± 4115	0.8853
% expenditures on ASF	28 ± 16	24 ± 13	33 ± 11	0.0706

¹IP=intervention caregiver receiving ENAM loan; IC=control caregiver in intervention community; CC=control caregiver in control community; ²% (n); ³mean ± standard deviation

1. *Completion of proposal and initiation of field data collection by Ugandan student:* The Ugandan student, Samuel Oluka, successfully completed coursework towards the Master of Philosophy degree in Nutrition. The student received guidance from ENAM project team members (Lartey, Sakyi-Dawson, Marquis, Colecraft) to develop a proposal to explore constraints to animal source foods in children's diets in a rural community in Uganda. He returned to Uganda in June 2006 to initiate activities for data collection for his thesis work. In September, Marquis, Sakyi-Dawson and Colecraft traveled to Uganda to assess the student's progress in the field data collection, provide needed guidance, and also establish links with Makerere University, VEDCO, and the Sustainable Rural Livelihoods (SRL) program.

2. *Advertising for students:* Letters were sent to the department heads of the Ghana team members requesting for students to be attached to the project for their thesis research.

3. *Completion of proposal write-up and field data collection by a Ghanaian student:* Gladys Adjei received guidance from ENAM project team members (Lartey, Marquis, Sakyi-Dawson, Colecraft) to successfully develop and defend their research proposals. The two proposals were entitled *Contribution of animal source foods to the total dietary intake of children in the Winneba area (Gladys Adjei)*. Gladys has completed her field data collection and is in the process of analyzing her data and writing up the results.

4. *Presentation of results.* An abstract on Gladys Adjei's master's thesis work was submitted to Experimental Biology. The work will be presented by Dr. Colecraft at the April meetings.

Jim Ellis Mentorship Award

Problem Statement and Approach. Research questions were developed that were not within the immediate scope and budget of the original project. The Jim Ellis Fellowship provided an opportunity to expand the project with graduate student research.

Planned activities: Support for the field research of two master's students working with the ENAM project – one in Uganda and one in Techiman.

Importance: As mentioned above, conducting

similar research in Uganda provides an opportunity to test the problem model in another setting. The second research question, focused on whether the IGA is associated with ASF or not, will help guide future interventions.

Plans to accomplish the activity: It was planned that one Ugandan and one Ghanaian student would apply for the Jim Ellis fellowship, and if awarded would conduct original research that informed the project.

Progress. Both of the master's students (Oluka and Christian) submitted a Jim Ellis Fellowship proposal and were awarded the fellowship. Christian has completed his field work and Oluka will be finished in December. Christian has submitted an abstract of his study results to the Experimental Biology meetings and will be presenting there in April 2006.

Activity 4. Curriculum (Nutrition Extension) Development

Problem Statement and Approach. There is a lack of systematic training of professionals in extension principles as they related to nutrition practice and little integration of the agriculture and nutrition disciplines. Given the multifaceted nature of nutrition problems and the need for integrated approaches to effectively identify and address these problems, there is a need for the development of academic curricula to train future practitioners in integrated approaches.

Planned activities: Develop an undergraduate course as well as continuing education training for current practitioners.

Importance: The current nutrition curriculum offered through the Department of Nutrition and Food Science at the University of Ghana can be enhanced through qualitative and interdisciplinary methodological perspectives that offer wider understanding of the role that the Nutrition plays in contributing to sustainable livelihoods. The development of a nutrition extension curriculum for the University of Ghana will expand opportunities within the sub-Saharan African region for training in applied community-based nutrition, public health

and agriculture. It is anticipated that the program will enhance research and outreach capabilities to address ASF and other agriculture, nutrition, and health issues in the region.

Plans to accomplish activity: It was planned that the program manager would take the leadership for this activity. Consultations and deliberations were to be held with Dr. Rafael Perez-Escamilla (University of Connecticut, Storrs), the project team members and other stakeholders from governmental and nongovernmental institutions to obtain input into the development of the curriculum. Course materials were to be identified through internet searches and interactions with stakeholders. Finally, it was planned that the developed curriculum would be submitted to the appropriate University of Ghana academic board for approval.

Progress.

Planned outputs and completion of tasks:

1. *Consultations with Dr. Perez-Escamilla:* The team interacted with Dr. Perez-Escamilla during his visit to Ghana Oct-Nov 2005. He shared his experiences in nutrition extension during a seminar that was attended by students, agriculture, nutrition and food science lecturer and representatives from the Ghana Health Services and Women in Agricultural Development. Deliberations with the project team members (all Ghana-based, and two US-based) yielded the following outcomes:

- The need to form linkages between academia and governmental and non-governmental organizations as well as industry for effective delivery of nutrition outreach services.
- The need for funding to sustain the extension delivery program.
- The use of trained paraprofessionals in the delivery outreach nutrition services
- Several issues were raised as to the practicality for the University of Ghana of the nutrition extension model presented by Dr. Perez-Escamilla. Some of the pertinent issues were:
- The university currently does not have the infrastructure to adopt the model. Specifically, the kind of network linkages with government and non-government organizations and industry are not present. The university currently plays

no role in actual delivery of nutrition services to communities and there is no formal link with organizations and institutions outside the university to translate research undertaken at the university to nutrition intervention programs.

- While it may be possible to pursue the extension model presented, it would be a lengthy process beyond the scope and time frame of the ENAM project.
- A compromise to attaining the ideal of developing a nutrition extension program was to incorporate extension principles in the existing nutrition curricula taught at the Department of Nutrition and Food Science to develop future professionals in the area of nutrition extension.

2. *Interactions with, academic, governmental and non-governmental stakeholders:* A 2-day work group meeting was convened with stakeholders from academic institutions and practitioners from nutrition-, health- and agriculture-based governmental and non governmental agencies to discuss the need for the course and course content. Institutions included: Ghana Health Services, Ministry of Food and Agricultural, University of Ghana, Plan Ghana, World Vision International, Rural Health Training School, Adventist Relief Agency, Christian Rural Aid Network, and Freedom from Hunger. The information from the work-group meeting was synthesized to inform the development of a course outline comprising objectives for the course, credits, topics to be covered, means of evaluation, and teaching materials.

3. *Submission of course description and supporting materials for approval:* Proposal for the course, outline of topics and supporting materials were completed and submitted to the University of Ghana, Faculty of Science academic board. Approval of the course has been obtained. The course will be offered in September 2007.

GENDER

This section addresses the following two questions asked by USAID:

- 1) How will gender relations affect the achievement of sustainable results?

2) How will the proposed results affect the relative status of men and women?

Research and development activities. The primary objective of the ENAM project is to improve the nutritional status of young children in sub-Saharan Africa. In Ghana, agriculture production, food preparation and child care, including child feeding, are gender defined. Typically, men provide the starch base of the meal (e.g., corn, millet, sorghum, cassava, yam), and women are responsible for the ingredients that are used in the accompanying sauce/stew (e.g., tomatoes, onions, okra, eggplant) – including any ASF that is used. Women own small animals; however, their ability to slaughter for home consumption or sell the animal for cash may be limited by the need for approval of male adult family members. Our results to date demonstrate that most ASF that is consumed in the home is purchased, not raised. Thus, increasing income of which women maintain control may provide an opportunity for them to purchase ASF and improve the family diet.

Women are the primary child caregivers; however, actual practices may differ from the stereotypes. The ENAM project is carried out among communities with different religions and tribal affiliations. The social-cultural influences have to be evaluated in each region/community to determine how specific gender issues limit or enhance the intervention approaches and the long-term success of the program. This project, with a focus on child well-being, relies heavily on women. The ability of those women to respond and participate depends in part on their own cultural environment. The project has been transparent about its activities to the entire community, and many activities have benefited men and women alike (e.g., training on fish smokers and poultry raising) to increase the acceptance of women's participation. In addition, all participants obtained the approval of their family before receiving a loan.

The project goal will be accomplished through targeted income-generation and skill building activities to caregivers of children 2-5 years of age and their households, as well as interactions with the entire community to sensitize it to the problems, consequences, and solutions for child malnutrition.

Sensitization activities for the entire community help to improve the acceptability of the targeted activities and increase the likelihood that there is social support for the caregivers to engage and sustain the new IGA and child care practices. The interventions work to improve knowledge and skills to enhance access to ASF through income-generation activities and processing and storage technologies for ASF. By strengthening caregivers' economic capabilities and removing their knowledge and skill barriers, the project empowers caregivers to adequately address the nutritional needs of themselves as well as their children.

It is not our intention to change a woman's traditional role in providing food or alter the division of labor in the household but work to increase the level and success of women's participation in economic endeavors, increase their control of their own ASF-related resources, and improve their access to health, agriculture, and other information relevant for their child's health. The research examines the empowerment of women in relationship to food access and child feeding.

Training activities. The project provides training through workshops, coursework, and research opportunities for students at the university. The training is for both men and women; a special emphasis is placed on encouraging women who are training in agriculture-related areas to increase the number of women in the field, however we were not successful this past year in identifying such students. Only female and male nutrition students were supported. The program manager position provides Dr. Esi Colecraft, a Ghanaian, an opportunity to work closely with faculty at ISU and the University of Ghana, and establish herself as a young researcher in Ghana. She has been approved as an adjunct faculty member at the University of Ghana and taught one course in the nutrition department during the past semester, and is teaching one class again this semester. Two of the three regional field coordinators are female; all three coordinators have excellent rapport with the caregivers and provide an excellent role model for community residents. Finally, the initiation of the nutrition extension curriculum is expected to help many female students

in the future by opening additional employment opportunities for them.

The research questions that have been described above will be documented through data collection at baseline and at regular time intervals. All data collected at the individual level will account for gender and age as well as other demographic characteristics, such as work activities, educational experience, marital status, parity for adult women, among others. Similar characteristics will be collected for group activities --for example, we will document the age, sex, and other relevant characteristics of those attending training sessions, community-based or formal school educational activities, and other group activities. Individuals may play many different roles within a household or a community, and these roles may change over time or season. Qualitative data will also be collected on participants' perceptions of their roles and how they view any changes with intervention participation.

POLICY

Interacting with policy makers has been our strategy throughout this grant. Our planning grant included interviews with policy makers at the national, regional, and local levels to elicit their opinions about barriers to ASF and feasible interventions. Our workshops in February 2004 (develop the program model), June 2005 (identify interventions), and July 2006 (identify nutrition extension curricula needs) have included government and non-governmental administrators working in the field of agriculture and health, including representatives of the Ministries of Women and Children's Affairs, Food and Agriculture, and the Ghana Health Services. The Ghana staff has visited with the directors' offices of the Ministry of Agriculture and Food and Ministry of Health/Ghana Health Services to update the individuals on the project. Many of these leaders have participated in public presentations of the project – for example at the recent African Nutritional Epidemiology Conference in August 2006. There is a particular interest from the Women in Agriculture Development and the Ghana Health Services staff to see the ENAM project move forward with a nutrition curriculum

that could be used for continuing education for their field staff. The course that has been approved for University of Ghana is the first step in developing such a curriculum.

The project has plans to produce a twice yearly one-page fact sheet. Although we are behind schedule in this particular activity, we intend to produce the informational sheet for dissemination to governmental and non-governmental institutions and organizations working in related fields. We had planned to have representatives of key institutions serve in the role of an advisory committee. However, two of our Ghanaian researchers have had less than satisfactory experiences with advisory boards recently and the group decision was to consult with experts from a variety of organizations for every major activity that is initiated (which has been done as demonstrated in the paragraph above). Finally, different members of the team have visited US-AID whenever it has been possible to meet with them.

OUTREACH

The project is focused on working with community-based women's groups in three regions of Ghana: Central, Brong-Ahafo, and Upper East. These represent the three main agro-ecological zones of Ghana. All project activities are participatory. Community residents have been involved from the Planning Grant stage to identify the problems and intervention approaches that should be used. Residents have been full partners in the formation of their groups, the selection of activities in which they participate, and the rules that their group follows. Training opportunities take place in the community and include those for all residents as well as those for the participating women's groups. The government extension staff has been kept informed of the project and collaborations occur as is possible.

As one activity of this project, Dr. Colecraft is developing a nutrition extension course that will be the first of a curriculum for an academic program that would span nutrition and agriculture. There is interest in also developing a certificate/ diploma program that would serve the needs of extension agents who require continuing education opportunities. These would be offered through the

University of Ghana and the certificate/diploma program has been informally requested by the Women in Agriculture Development Office of the Ministry of Food and Agriculture and the Ghana Health Services. Dr. Colecraft has been appointed as a Part-time Lecturer in the Department of Nutrition and Food Science at the University of Ghana for the academic year 2005/06 to facilitate this goal.

DEVELOPMENTAL IMPACT

Environmental impact and relevance. The project activities will contribute to improved use of ASF, due to improved harvesting / husbandry, handling, processing and marketing of ASF in the study communities and beyond. This implies that the water bodies, forest and the grasslands from which the ASF are directly or indirectly produced or obtained will be more efficiently utilized, thereby result in positive environmental impact.

Agricultural sustainability. The activities targeted by the project encourage the production, distribution and utilization of the livestock and other agriculture products in a sustainable fashion. The production generates by-products which can be used for composting / manure for soil fertility management. Improving soil management will improve production of all agricultural products.

Biotechnology. Ghana has embraced biotechnology in many areas; the wide spread promotion and production of high lysine (local hybrid) corn is one example. Fermentation is a food processing technique that is also common throughout Ghana and offers a mechanism for mothers to provide safe food for their young children. This project examines all processing methods that will promote better nutrition for children.

Contributions to U.S. agriculture. This project has no direct effect on US agriculture. However, it has provided international training for undergraduate students to learn about the West African culture, habits, and agricultural practices. Knowledge gained through these experiences with the ENAM project will benefit future professional development that may benefit the US.

This project's objectives focus on the reduction of poverty through household income generation

activities. This is consistent with US government priorities to reduce hunger and poverty in Africa. Furthermore, collaboration between US-based scientists and partners in the sub-Saharan Africa region will broaden the scope of US disciplines and research, encouraging greater responsiveness to international issues and enriching coursework at Iowa State University.

Contributions to host country. The primary objective of the ENAM project is to improve the nutritional well-being of vulnerable children in sub-Saharan Africa and to build a healthy and productive population base for future development. Over half of childhood mortality can be attributed to malnutrition. Improved diets of the young population will contribute to the future society.

The development of an integrated curriculum that addresses agriculture, nutrition, economic, social, and community issues is on-going. With increased collaborations across the continent, the curriculum developed at the University of Ghana may be able to influence Makerere University's curricula. This curriculum will facilitate continued problem assessment and identification of promising interventions, thereby adapting university research to the real needs of vulnerable groups. The highly interactive nature of the project fosters continued dialogue and information sharing with communities and organizations. This ultimately will generate recommendations and policy initiatives leading to more integrated regional interventions in health and agriculture. The training of Ghanaian and Ugandan graduate students will have a long-term effect through their influence as young professionals.

Linkages and networking. The project's activities in Ghana, Uganda, and the US integrate disciplines and develop local and regional networks to reduce poverty and promote children's well-being. The resource-poor, sub-Saharan Africa region will benefit through the sharing of resources and expertise in mutually beneficial ways. Uganda has few trained nutritionists and a graduate program that is just starting this year. The country will benefit from the training that the well-established nutrition program at University of Ghana is providing for one of their talented Makerere University students. Ghana is benefiting from the enrichment of their graduate

student population with a talented Ugandan. The Ghana staff are working on furthering the collaborations with district-level government agencies to combine nutrition (and other) education resources in the area.

Collaboration with international research centers (IARCS) and other CRSPs. The ENAM project is not presently collaborating with the IARCS. We have had some collaboration with one scientist from the Bean and Cowpea CRSP (Dr. Esther Sakyi-Dawson, University of Ghana) who has completed a small preliminary study to look at the feasibility of drying meat for children's diets. Drs. Marquis, Sakyi-Dawson, and Colecraft meet with Dr. Kwasi Ampofo, who is the Reaching and Engaging Enduser Coordinator for Harvest Plus/CIAT in September in Kampala, Uganda to discuss opportunities for graduate students to visit CIAT and work with projects such as Harvest Plus.

OTHER CONTRIBUTIONS

Support for free markets and broad-based economic growth. The development of market linkages for animal source food products is based mainly on free-market principles. Members of the local communities are provided with technical assistance and are being empowered to access appropriate services from governmental and private sources.

Contributions to and compliance with mission objectives. The overall goals of the mission are to (a) foster a healthier, better educated, and more productive population; and (b) increase the effectiveness of African institutions in promoting a vibrant private sector and democratic governance. To accomplish these goals, the mission has four main strategic objectives; our project contributes directly to the third objective of improving the health status of the population. Through collaborations of the project with staff from the district Ghana Health Services, we are promoting community-based service delivery and linking health to other development activities at district and community level. Although this project is not specifically targeted to people living with HIV/AIDS, it is targeted to the neediest, some of whom will be infected with HIV.

Concern for individuals. Freedom of individuals to make informed choices for themselves underlines all project processes. Individuals are invited to participate in group activities; participation is an individual choice, and the participants are informed of their right to disengage from any or all activities at any time. The data collection has been reviewed and approved by the Institutional Review Board at Iowa State University and the University of Ghana, and the project assures confidentiality of the data.

Support for democracy. All technical assistance to the project provided to community members through participatory group activities enhances social learning and mutual support. The process of group dynamics among community members encourages active participation in decision-making and may translate to increased empowerment of the community as individuals and as a whole.

Humanitarian assistance. Access to adequate, safe food is a human right. This project is focused on increasing the use of nutrient-rich animal source foods in the diets of young children to improve their health, growth, and cognitive development. The activities do not provide a direct transfer of food but will increase households' ability to access a quality diet for their children.

LEVERAGED FUNDS AND LINKED PROJECTS

The total value for leveraged funds for the ENAM project during 2006 was \$16,030. The sources of those funds were as follows:

University of Ghana, office space for Department of Animal Science (\$500/mo*12), \$6,000.

NIH (Research on optimal nutrition for young children), meeting space, transportation, and equipment for Marquis, 09/02/2005-08/07/2006, \$2,553.

Ministry of Food and Agriculture, field personnel, \$2,473; office space (\$300/mo*12), \$3,600.

VEDCO (Ugandan NGO working with the ISU SRL program-support for ENAM master's student), office space and use of motorcycle, \$156; staff assistance, \$769.

Makerere University (Uganda-support for ENAM visit), car and driver, \$479.

TRAINING

Degree

Adjei, Gladys. Ghanaian, F, U of Ghana, Nutrition, MS.
Addo, Adolphina. Ghanaian, F, ISU, Nutrition, MS.
Aryeetey, Richmond. Ghanaian, M, ISU, Nutrition, PhD.
Christian, Aaron. Ghanaian, M, U of Ghana, Nutrition, MS.
Oluka, Samuel. Ugandan, M, U of Ghana, Nutrition, MS.
Pareja, Rossina. Peruvian, F, ISU, Nutrition, MS.
Fox, Melissa. American, F, ISU, Nutrition, BS.
Danowsky, Elizabeth. American, F, ISU, Nutrition, BS.
Timpo, Olivia. Ghanaian, F, U of Connecticut, Nutrition, MS.

Non-Degree

Community training in fish smoking, February 20-23, 2005 and June 19-22, 2006 in Winneba and Navrongo, Ghana. Facilitated by Margaret Aguu and Alice Dawson. To expand caregiver household income through alternative income generation activities that will lead to increased access to ASF. Attended by 88 participants (5 male and 83 female).

Community training in poultry production, February 25, 2006 in Winneba, Ghana. Facilitated by Professor Ben Ahunu, Dr. Emmanuel Canacoo, and Mr. Kofi Adjololo. To expand caregiver household's income through alternative income generation activities that will lead to an increased access to ASF. Attended by 66 participants (4 male and 62 female).

COLLABORATING PERSONNEL

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Uganda

Muyanja, Charles. Makerere University, Food Science, PhD, Senior Lecturer

United States

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Jensen, Helen. Iowa State University, Economics, PhD Professor
Lonergan, Elisabeth. Iowa State University, Animal Science, PhD, Assoc. Professor
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It should be noted that Dr. Marquis is now a faculty member of McGill University in Montreal Canada and the School of Dietetics and Human Nutrition unofficial provides support to the ENAM project through Dr. Marquis' salary.

PUBLICATIONS

Esi Colecraft, Grace S. Marquis, Richmond Aryeetey, Owuraku Sakyi-Dawson, Anna Lartey, Benjamin Ahunu, Emmanuel Canacoo, Lorna M. Butler, Manju B. Reddy, Helen H. Jensen, Elisabeth Huff-Lonergan. Constraints on the use of animal source foods for young children in Ghana: a participatory rapid appraisal approach. *Ecology of Food and Nutrition*, 45: 351–377, 2006

ABSTRACTS/PRESENTATIONS

Experimental Biology. April, 2006. San Francisco, CA.

E Colecraft, GS Marquis, AA Lartey. Nutritional status and dietary animal source food diversity of 2- to 5-y old Ghanaian children living in rural and peri-urban communities in a coastal district.

African Nutritional Epidemiology Conference. 15th – 18th August 2006. Accra, Ghana.

E Colecraft, GS Marquis, AA Lartey. Nutritional status and dietary animal source food diversity of 2- to 5-y old Ghanaian children living in rural and peri-urban communities in a coastal district.

Abstracts submitted for Experimental Biology 2007 (Washington DC)

E Colecraft, GA Adjei, A Lartey, and GS Marquis. Contribution of animal source foods to total iron intake of children in coastal Ghana

AK Christian, A Lartey, E Colecraft, O Sakyi-Dawson, B Ahunu, and GS Marquis. Caregivers'

Income Generation Activities and Diversity of Animal Source Foods in Children's Diets in Ghana.

EK Colecraft, GS Marquis, A Lartey, O Sakyi-Dawson, B Ahunu, Lorna M Butler, Helen H

Jensen, Manju B Reddy, Elisabeth Lonergan. The magnitude and pattern of purchased ready-to-eat foods in the diets of rural Ghanaian children.

Grace S Marquis, Kimberly Harding, Esi K Colecraft, Melissa Fox, Owuraku Sakyi-Dawson. Seasonal patterns of severe food shortages vary by region in Ghana.

LEAD PRINCIPAL INVESTIGATOR

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**BEEF AS A SOURCE OF VITAMIN B-12, IRON AND ZINC TO IMPROVE
DEVELOPMENT OF INFANTS FED LOW AMOUNTS OF ANIMAL PRODUCTS**

NARRATIVE SUMMARY

In a low-income area of Guatemala City we reported previously that almost two thirds of infants aged 7 to 12 months had plasma vitamin B-12 concentrations that indicated depletion or deficiency of the vitamin. The only dietary source of this vitamin is animal source foods (ASF) and diets of mothers and young children in these communities, as in most poor regions of the world, are low in ASF and consequently vitamin B-12. Because severe vitamin B-12 deficiency has adverse, possibly permanent effects on infant and child development, this study was designed to test associations between B-12 status and indicators of child health and function, and the effect of food-based interventions on B-12 status and child growth, cognitive and motor development, activity and behavior. In addition, the effect of beef supplementation on iron and zinc status was determined. Subjects were 304 Guatemalan children, aged 1 year at enrollment, and their mothers, recruited from 2003 through 2005. 80% of the infants were still consuming some breast milk. The three equi-caloric dietary interventions, provided daily under supervision for 9 months, were: a beef meal (72 g beef, 0.56 ug B-12 – the RDA is 0.9 ug/d), a control meal (commercial turkey-rice and fruit, 0 ug B-12), and the control meal plus added vitamin B-12 (0.86 ug B-12). Indicators of child function and development were measured throughout the intervention, and outcomes in the beef and B-12 supplemented groups compared to those in the control group. At baseline, a high percentage of the infants were B-12 depleted (30% deficient and 20% marginal status) as were their mothers (36% deficient and 33% marginal status). Strong, statistically significant predictors of low plasma B-12 concentrations in infants at 12 months postpartum

included lower maternal plasma B-12, less vitamin B-12 intake from complementary foods (primarily powdered cow's milk), more dependence on breast feeding, and smaller household size. Infants with plasma vitamin B-12 levels that indicated deficiency had poorer motor skills (fewer could stand, walk alone or squat), and those consuming less than the average vitamin B-12 intake had a lower mental score on the Bayley assessment exam than those consuming above the average amount. Mothers with deficient plasma vitamin B-12 concentrations had a 60% greater risk of depressive symptoms, after controlling for socioeconomic and other variables.

At the end of the study there were no differences among treatment groups in B-12 or iron status measures, or any other outcome. Rather, predictors of status at 21 months were the infant's plasma B-12, maternal plasma B-12 at baseline, and cow's milk consumption during the study. Deficient plasma B-12 levels at the end of the study, which persisted in 41% of infants, were still associated with delayed motor development. Furthermore, deficient children were more stunted and showed more dysregulation of behavior. We conclude that food-based interventions to improve maternal and infant B-12 supplementation must be done during pregnancy and/or lactation to prevent adverse effects of deficiency in infants.

RESEARCH

Problem Statement and Approach. The high global prevalence of vitamin B-12 deficiency has been recognized relatively recently. The World Health Organization, for example, held a Consultation on vitamin B-12 in October, 2005, the first in more

than 40 years. A review by the Principal Investigator of this project concluded that about 40% of individuals studied in Latin America had deficient or marginal plasma vitamin B-12 concentrations. In our previous research in Guatemala City we observed that plasma vitamin B-12 was deficient or marginal in about one third of school children, and 30% of lactating women at three months postpartum and 12% of their breastfeeding infants, and two thirds of infants aged 7 to 12 months. The main cause of the vitamin B-12 deficiency appears to be a low intake of animal products, as B-12 is only found in animal source foods unless the foods are fortified with the vitamin.

This research was designed to answer several important questions based on these observations. The most important is whether the low plasma vitamin B-12 levels in infants are associated with adverse effects on their mental and motor development, activity and behavior, and on maternal depressive symptoms. Severe deficiency has been shown to have these effects in other studies. Second, we determined whether meat or vitamin B-12 supplementation of young children with a high prevalence of vitamin B-12 deficiency improves their nutritional status, growth and development. Third, predictors of infant vitamin B-12 deficiency at baseline were investigated, including their diet, maternal B-12 status, and breast milk B-12 concentrations.

Specifically, the research evaluates the effects of supplementation with beef, or vitamin B-12, on the cognitive and motor development, activity, temperament, growth and morbidity of these young children. The three randomized intervention groups (recruitment goal 80 children per group, completion goal 60 per group), providing a similar amount of calories, are: 1) a beef supplement; 2) a low meat control meal (commercial turkey and rice dinner and fruit infant foods); and 3) the same control meal fortified with vitamin B-12.

The relevance to global agriculture and development is that a low intake of animal products may cause vitamin B-12 deficiency and have permanent adverse effects on child development and human capital formation. Documentation of such adverse effects caused by vitamin B-12 deficiency could increase attention to the need for increased

animal source food intake and production in low income populations of developing countries, and the importance of animal source foods for normal human development.

Progress. After an initial pilot testing phase, the intervention started in October 2003 with funding from the National Cattlemen's Beef Association. Funding from the GL-CRSP was added starting in October 2004. From October 2003 to December 2004, children were enrolled into the three randomized groups fed the supplemental foods daily, under observation. At 0, 3, 6 and 9 months of intervention, data were collected on usual diet, anthropometry, cognition and development, behavior, activity, and morbidity. Maternal measures at baseline included plasma B-12, a breast milk sample for B-12 analysis, anthropometry, diet, socioeconomic and other household data, and reported depressive symptoms. Blood samples to assess nutritional status were collected at baseline and after the nine months of supplementation. The intended number of children completed the study (201 completed, compared to the desired final sample size of 180). All fieldwork was finished by September 2005. Most analyses have also been completed, except statistical analysis of observed physical activity in children and analysis of breast milk for vitamin B-12. There were no substantial modifications in the original protocol or work plan.

Preliminary results. At baseline, 80% of the infants were partially breastfed, 29.8% had marginal plasma vitamin B-12 concentrations (200-300 pg/mL), and 19.5% had deficiency (<200 pg/mL). Of the mothers, 37.5% had marginal vitamin B-12 status and 32.5% were deficient. Anemia was present in 14.5% of infants and 9.8% of mothers, and 39.4% of infants were iron deficient. Lower infant plasma vitamin B-12 concentrations were predicted by lower maternal plasma vitamin B-12, higher B-12 intake from complementary foods (almost all of which came from cow's milk), higher frequency of breastfeeding (because the breast milk contains much less vitamin B-12 than cow's milk), and smaller household size ($P < 0.0001$).

In the mothers, 43% had a high depressive symptoms score, which was predicted by lower

plasma vitamin B-12 concentrations, a lower platelet count, a higher body mass index, and having more children (all $P < 0.05$). The relative risk for having more depressive symptoms was 1.6 for women with deficient vs. adequate plasma vitamin B-12 concentrations ($P < 0.005$).

The baseline analyses also show that vitamin B-12 deficiency is adversely associated with delayed motor development. Infants with deficient plasma vitamin B-12 concentrations had poorer performance of motor skills related to secure walking, compared to adequate infants ($P < 0.005$), and those consuming < 1.44 g/d of vitamin B-12 from complementary foods (the median intake) had a lower mean Mental Development Index score than infants consuming > 1.44 g/d ($P < 0.05$). In summary, as expected the infants and their mothers have a very high prevalence of vitamin B-12 deficiency. This is accompanied by a higher rate of maternal depressive symptoms, and poorer walking skills and mental development in the infants.

After the nine months of intervention, the change in plasma B-12 from baseline was -18 pg/mL in the control group compared to $+82$ pg/mL in the B-12 group and $+32$ pg/mL in the Beef group, but these differences were not statistically significant due to the large SD. There was no significant difference among treatment groups in final prevalence of B-12 deficiency, hemoglobin or hematology, iron status, or growth. Also, there were no differences in Bayley Motor or Mental Score, language development, auditory or expressive comprehension, reactivity, dysregulation or growth. However, 41% of infants remained B-12 deficient or had marginal status at the end of the study. When compared by B-12 status, and controlling for age, SES, environment, and the baseline value of each variable, deficient and marginal status infants had significantly lower weight and length Z-scores compared to those with adequate status ($P < 0.0005$), indicating that they had poorer growth from baseline. Motor development scores in the Deficient group were significantly lower than those in the Adequate group ($P < 0.01$), and Dysregulation was significantly greater ($P < 0.02$).

There are several possible explanations for the lack of differences in outcomes after 9 months of B-12 or beef supplementation. First, it is apparent that

the B-12 status of these infants tracks strongly. We know from previous studies in these communities that plasma B-12 at age 7 months is strongly correlated with plasma B-12 at age 12 months. In this study a similar situation occurred, with plasma B-12 at 21 months correlated with concentration at 12 months ($r = 0.54$, $P < 0.0001$) as well as with the mother's value at 12 months ($r = 0.22$, $P < 0.001$). It therefore appears that infant B-12 stores are already depleted in early infancy (probably in utero) and that supplementation with low amounts during early childhood is insufficient to overcome this early depletion. Maternal deficiency has a strong association with infant deficiency presumably because the mother was depleted during pregnancy and lactation, and her breast milk B-12 was low (samples collected at baseline in this study are being analyzed for B-12 to confirm the inadequate breast milk B-12 content).

Another important factor is that in a study where other complementary foods are consumed ad libitum, with intervention only during one meal a day, the B-12 content of these other foods may obscure any effect of the intervention. Indeed, cow's milk, consumed in increasing amounts during the study, is relatively high in vitamin B-12 and its consumption did correlate with final infant plasma B-12 concentrations ($r = 0.40$, $P < 0.001$). Controlling for cow's milk intake during the study did not alter the conclusion that the B-12 or beef supplements had no detectable impact, however.

We believe that future interventions need to provide more than the daily recommended intake of vitamin B-12 in such depleted populations. For example, no infant consuming > 2.25 ug/d B-12 from dairy sources (powdered cow's milk in most cases) had deficient B-12 status, and all consuming > 4 ug/d from dairy sources had adequate status, at age 21 months. Interestingly, in the GL-CRSP feeding trial in Kenya, supplementation with 60-80 g beef/d (similar to the 70g/d given to infants in the current study) did improve B-12 status of schoolers, although the effect was greater by the end of two years of supplementation compared to one year. The intake of other sources of B-12 (including milk) was very small in Kenya, however. Also, our research demonstrates the critical importance of improving

maternal B-12 status during pregnancy and lactation; unless this is done, infants and young children are at high risk of becoming vitamin B-12 deficient.

GENDER

A total of 158 boys and 146 girls were enrolled into the study. There were no gender differences in outcomes at baseline or post-intervention.

The mothers of all the 304 infants also participated in this research. This research has demonstrated that 69% of the mothers are vitamin B-12 depleted or deficient and this is associated with a higher risk of deficiency in their infants at 12 months postpartum (and presumably much earlier during the first year of life), and with higher risk of maternal depressive symptoms. We also plan to analyze the breast milk vitamin B-12 concentration of these women and baseline to confirm that maternal vitamin deficiency leads to lower secretion of the vitamin in breast milk and subsequently greater risk of infant depletion. The potential implications are that these women need to learn the importance of increasing their animal source food intake during pregnancy and lactation, they may also need supplementation with the vitamin, and a national B-12 fortification program may need to be considered.

A group of 12 women from the community were trained as Community Motivators for this project. They were responsible for contacting mothers, setting up clinic visits, distributing and observing the consumption of the food supplements, collecting morbidity data, and alerting the project supervisory personnel about medical or other problems. This training has provided these women with qualifications that will improve their future employment opportunities and their knowledge of the importance of nutrition for child development.

Other training included two licensed Guatemalan psychologists who were instructed by the lead Guatemalan psychologist and Dr. Maureen Black on the application of child development tests. The Field Director, a female Guatemalan physician, has been trained in data entry and analysis and preparing a manuscript on our experience with developing and

testing the acceptability of our beef test meal by the mothers and their infants.

POLICY

This research makes several important contributions to our knowledge of nutritional status problems of mothers and infants in areas of the world where the consumption of animal source foods is low. Inadequate intake of these foods causes maternal depletion of vitamin B-12, which during pregnancy results in low B-12 stores in the infant at birth, and inadequate amounts of the vitamin in breast milk.

Several changes in policy need to be made as a result of the analyses completed to date. The first is to improve the intake of animal source foods by mothers and young children. In these peri-urban communities, where a wide variety of cheaper meats is available, the most feasible strategy is probably education of the mother and the household about the importance of consumption of these foods (which are also the main source of other nutrients such as absorbable iron and zinc) for healthy pregnancy outcome and child development. This strategy was successful for improving animal source food consumption in Lima, Peru. Encouragement to include dried or whole milk intake of mothers, infants and children would also increase their B-12 intake substantially. Another potential strategy, which is under discussion, is the addition of vitamin B-12 as a fortificant to wheat or maize flour. Wheat flour is currently fortified with folic acid but not vitamin B-12 in Guatemala and many countries in the world.

Activities are already underway to ensure that policy-makers are involved in evaluating the results of the study and aware of potential strategies to improve the situation.

1. Preliminary results on the vitamin B-12 deficiency problem in Guatemala and other Latin American countries were shared with the Nutrition office at the Pan American Health Organization (PAHO) in Washington D.C. PAHO is the regional office of the World Health Organization responsible for Latin America. This led to a Consultation on

folate and vitamin B-12 deficiency in The Americas to recommend the addition of vitamin B-12 as well as folic acid as fortificants for flour in Central and South America (see Allen, L., *Folate and B-12 status in the Americas*, Nutr. Rev. June 2004, and *Flour Fortification with Iron, Folic Acid and Vitamin B-12*, PAHO, Washington D.C., 2004).

2. Results of the baseline analyses were reported briefly in an invited lecture by Dr. Lindsay Allen on dietary problems of preschoolers, at the International Congress of Nutrition in Durban, South Africa, September 2005.

3. Dr. Allen was one of the organizers of a WHO Consultation on Folate and Vitamin B-12, held in Geneva, October 2005. She worked with WHO in the development of a global database of the prevalence of vitamin B-12 deficiency which revealed that this is a widespread problem, and presented a paper on the evidence that a lack of animal source foods was the main cause of vitamin B-12 deficiency in developing countries.

4. Dr. Allen presented in a session at the American Academy for the Advancement of Science, January 2005, in Washington D.C., where she and the GL-CRSP Director discussed the importance of animal source foods, and the results of the nutritional intervention in Kenyan schoolers were presented.

5. Dr. Allen presented an invited lecture on Animal Source Foods as a Source of Micronutrients in Developing Countries, at the Board for International Food and Agricultural Development meeting, held in Des Moines, Iowa, October 2005, in conjunction with the World Food Prize ceremony.

OUTREACH

The primary outreach target will be women and children in regions of the world where the intake of animal source foods, and subsequently of vitamin B-12, is low. The mothers and children in this study are broadly representative of the high proportion of people in low income countries who consume inadequate amounts of animal source foods. We have learned from this Guatemalan study

that consumption of cow's milk, rich in vitamin B-12, improves the vitamin B-12 status of these young children so it should be encouraged as a complementary food after the recommended six-month initial period of exclusive breast feeding. It is also apparent that the nutritional status of these women is inadequate to support the nutrient requirements and normal development of their infants. In the GL-CRSP funded Child Nutrition Project in Kenya, we demonstrated that inclusion of small amounts of meat or milk in snacks provided at school virtually eliminated the high prevalence of severe vitamin B-12 deficiency. This is a feasible strategy in many situations. Additional extension approaches include the need for nutrition education of women and households on the importance of animal source foods; and increased emphasis on household animal source food production and preservation in agricultural development and training programs.

Dr. Ramirez is responsible for research on food security at INCAP and will follow up appropriately with the agricultural community through INCAP on the need for increasing animal source food intake of mothers and young children.

DEVELOPMENTAL IMPACT

Environmental impact and relevance. There is no direct environmental impact of this project. In the longer-term, it must be recognized that sufficient production and consumption of animal source foods is required for optimal human nutritional status and capital formation, and that this need should not be ignored even where there are environmental constraints.

Agricultural sustainability. This research will make it more evident that the concept of agricultural sustainability must include production and consumption of animal source foods, because of their demonstrated importance in improving dietary quality (micronutrient content of the diet). In low income countries, unless staple crops can be fortified with micronutrients such as vitamin B-12, and fortified foods are consumed in reasonable amounts by subsistence households, animal source foods are the only dietary source of some micronutrients

such as vitamin B-12, and the major source of iron, zinc and other micronutrients. It is becoming increasingly accepted that it is infeasible to provide vitamin-mineral supplements for all populations in developing countries who need them; at present these are given only to some pregnant women and a few young children. Thus the definition of agricultural sustainability must include a minimum level of animal source food production and consumption by the population.

Contributions to U.S. agriculture. The nutritional risks associated with avoidance of animal source foods, and especially meat, are not adequately appreciated in the U.S. or the world in general. For example, the practice of restricting the meat intake of children in the United States has become more common because some parents believe that “red meat” has adverse effects on health. In a recent study at UC Davis, for example, wealthier parents fed far less red meat to their children than did those in lower socioeconomic groups; 91% of lower income children and 100% of higher income children failed to meet the minimum number of meat servings. In an analysis of data from the National Health and Nutrition Education Survey (NHANES III), we found that plasma vitamin B-12 levels were significantly lower in those with lower intakes of meat. Many studies are revealing that lacto-ovo vegetarians or those who consume low amounts of meat, in industrialized countries have poor vitamin B-12 status, so meat needs to be consumed to ensure vitamin B-12 intake is adequate. In general, the study revealed the importance of meat consumption for the lactating mother, and the normal development and nutritional status of young children.

Contributions to host country. INCAP is one of the premier nutrition institutions in Latin America, and for more than 50 years has been dedicated to research and its application to prevent and treat malnutrition. INCAP has collaborated with UC Davis in several previous studies that confirm the high prevalence of vitamin B-12 deficiency in lactating women, their infants, preschoolers and schoolers in peri-urban Guatemala City. The proposed research will enable INCAP to understand the prevalence and etiology of vitamin B-12 deficiency during the critical first year of

life, as well as the adverse consequences of this deficiency, and eventually the need and application of strategies to prevent this wide-spread problem. This project has also increased the expertise of investigators at INCAP and enabled an important exchange with senior researchers who are working on this topic. The collaborative research has provided training and research skills with new methods of assessment, laboratory techniques, community-based research and especially in measures of child development. This is a critical area of interest to INCAP. The project has contributed to INCAP’s technical capacity and involvement in the area of micronutrients and will result in peer-reviewed and locally/regionally relevant publications. INCAP will transfer the information learned to its member states, increase awareness about the importance of vitamin B-12 deficiency, and guide related policy decisions such as the need to support animal source production and consumption, to fortify maize and wheat flour or other foods with vitamin B-12, and/or provide vitamin B-12 containing micronutrient supplements to infants, pregnant and lactating women. Moreover, the research is highly relevant to the current incentive supported by the GL-CRSP to increase awareness of the nutritional importance of consuming animal source foods, and will inform development specialists and nutritionists in the region (and world) about their special importance for child development.

Linkages and networking. Dr. Ramirez is closely connected with Central America’s focus on sustainable agriculture and will share the results of this research with the member countries. Dr. Allen will continue to work closely with the World Health Organization in the publication of the Consultation on Folate and Vitamin B-12, where the baseline results of this study were presented. Dr. Black will share the child development results at meetings concerned with child health. The team has been partially supported by the National Cattlemen’s Beef Association which will publicize the results of this research. Preliminary results on the importance of animal source foods were presented to the Board on International Food and Agricultural Development, and at the American Association for the Advancement of Science, by the PI in 2005. The PI meets with the GL-CRSP investigators who will

be updated on the results of this research, including those in projects studying constraints to animal source food consumption.

Collaboration with international research centers (IARCS) and other CRSPs. Drs. Allen and Graham have worked previously with the GL-CRSP's Child Nutrition Program in Kenya, which included beef and milk supplementation of schoolers. Dr. Allen's group demonstrated the beneficial effects of the animal source food intervention on vitamin B-12 status of the Kenyan children. More recently Drs. Allen and Graham received GL-CRSP funding to analyze the contribution of animal source foods to the dietary intake of the Kenyan children, in collaboration with Dr. Marie Ruel of the International Food Policy Research Institute (IFPRI, a member of the CGIAR). They compared dietary diversity and animal source food intake as indicators of dietary adequacy and determined that dietary diversity was the best indicator of dietary quality when animal source food intake was very low, and that above a minimum level of intake, animal source foods significantly improve dietary quality.

OTHER CONTRIBUTIONS

Support for free markets and broad-based economic growth. This research will demonstrate the importance of animal source foods for adequate human nutrition, normal child development and human capital formation, thereby enabling broad-based economic growth. It will provide impetus to activities such as: nutrition education concerning the need to consume animal source foods; promotion of initiatives to increase animal source food production and consumption at the household, regional and national level; and innovative ways to preserve animal source foods and to feed them to young children.

Contributions to and compliance with mission objectives. Achievement of food security and consumption of a nutritionally adequate diet is an important objective of the GL-CRSP, and has long been an objective of USAID. This research will encourage renewed emphasis on the importance of animal source foods in agricultural production, and the role that animal production must play to

enable normal human development and capital formation.

Concern for individuals. This project made a substantial contribution to the women and children who participated in this research. Mothers and infants who were severely vitamin B-12 deficient at baseline were all treated with injections of the vitamin. Individuals with illness, and children diagnosed with severe developmental delays, were referred for medical attention and appropriate care. One meal per day was provided to each of the children during the 9 months they participated in the study. The mothers, their households, community motivators and project staff all gained an increased awareness of the importance of nutrition for child development.

Support for democracy. This research can demonstrate the fact that population groups, including those with limited resources, need to improve their nutritional status and human capital formation through adequate consumption of animal source foods. Increased attention to this issue will reduce risk of functional impairments such as poor child development and increased risk of maternal depression, creating individual opportunities for achievement and more stable and democratic societies.

Humanitarian assistance. If households cannot obtain access to a food supply that provides sufficient nutrients to support their needs, this engenders the need for short-term humanitarian support such as feeding programs, and remedial treatment with vitamin mineral supplements. In contrast, making animal source food production and consumption a focus of development programs will increase sustainability of a nutritionally adequate food supply for the population.

LEVERAGED FUNDS AND LINKED PROJECTS

The total value for leveraged funds for the BEEF project during 2006 is \$24,963. This project has been able to leverage personnel funds and with in-kind support of two co-investigators to ensure that the study is administered and progresses toward successful completion. There have been no linkages to other grants/projects during 2006. The project

period was January 1 – September 30, 2006 so values are for 9 months.

USDA-Agricultural Research Service (\$11,694; salary). Dr. Lindsay Allen is the Principal Investigator and the primary person responsible for all aspects of the study during FY04-05. She provides 10% of her time to this project.

USDA-Agricultural Research Service (\$5,863; salary). Setti Shahab-Ferdows is a graduate student supervising Dr. Allen's laboratory and is the main day-to-day UC Davis communicator with the field and with INCAP. She provided 20% of her time to this project. Duties included obtaining lab and other supplies, ensuring timely shipment of supplies for lab assays at INCAP and UCD, and some data analysis.

Support In-kind - Dr. Maureen Black (consultant, \$2,706, 2% time) is a trained child development expert/psychologist who has years of experience in assessing the impact of nutrient intervention studies on child development in developing countries, and in assessing mother-child interactions. She was responsible for training and development in all areas of child development in this study.

Support In-kind - Dr. Margaret Bentley (consultant, \$4,700, 2% time) is a Medical/Nutritional Anthropologist who has international experience in the assessment of food intake and feeding practices of infants and children; assessment of child activity (including a zinc intervention trial with INCAP in Guatemala which showed positive effects on activity); and ethnographic techniques that enabled us to understand the mother's perception of their child's health and development relevant to the cultural norm, and issues such as how to motivate the parents to adhere to the intervention. She provided guidance in the training of staff for the assessments of child activity, feeding and health and designed the pilot trials of infant acceptance of the supplementary foods.

TRAINING

Degree

Deegan, Kathleen, USA, F, University of California, Davis, Nutrition, PhD.

Shahab-Ferdows, Setareh, Iran, F, University of California, Davis, Nutrition, PhD.

Non-Degree

Statistical training, summer of 2006 at UC Davis in Davis, California, USA. Facilitated by Janet Peerson and Lindsay Allen. To learn statistical analysis and publication of biochemical and behavioral data sets using SAS statistical software. Attended by 2 participants (1 male and 1 female).

COLLABORATING PERSONNEL

Guatemala

Mejia, Rosa Mery. INCAP, Psychologist
Ramirez, Manuel. INCAP, Nutrition, MD & PhD,
Project Director

Ramos, Luisa. INCAP, Secretary

Salazar, Irma. INCAP, Data Entry

Zuleta, Clara. INCAP, Medicine, MD, Project
Supervisor

United States

Allen, Lindsay. Professor, Department of Nutritional
Biology, University of California, Davis and
Director, USDA-Western Human Nutrition
Research Center, PhD, Principal Investigator

Bentley, Margaret (Peggy). University of North
Carolina, PhD, Consultant

Black, Maureen. University of Maryland, PhD,
Consultant

Deegan, Kathleen. UC Davis, Nutrition, BS,
Graduate Student

Peerson, Janet. UC Davis, Statistics, MS,
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Shahab-Ferdows, Setareh. USDA-Western Human
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PUBLICATIONS

Jones, K.M. (2005) Vitamin B-12 Deficiency in Guatemalan Mother and Infants: Prevalence, Predictors, and Associations with Maternal Depression and Infant Development. Ph.D. thesis, University of California, Davis.

Jones, K.M., Ramirez-Zea, M., Zuleta, C., Allen, L.H. (2006) Prevalent vitamin B-12 deficiency in Guatemalan infants aged 12 months is predicted by maternal B12 deficiency and infant diet. *Journal of Nutrition* (In Press).

Jones, K.M., Black, M.M., Mejia, R-M., Zuleta, C.M., Ramirez-Zea, M., Allen, L.H. (2006) Depressive symptoms are associated with deficient plasma vitamin B-12 concentrations in low-income Guatemalan women 12 months postpartum. *Social Science Medicine* (submitted for publication).

Jones, K.M., Black, M.M., Mejia, R-M., Ramirez-Zea, M., Zuleta, C.M., Allen, L.H. (2006) Deficient plasma vitamin B-12 is associated with passivity and slow acquisition of gross motor skills among low-income, Guatemalan infants. *American Journal of Clinical Nutrition* (submitted).

ABSTRACTS AND PRESENTATIONS

Jones, K.M., Black, M.M., Mejia, R.M., Ramirez-Zea, M., Zuleta, C., Allen, L.H. Cognitive function, motor skills, and behavior of Guatemalan infants with highly prevalent deficient and marginal

plasma vitamin B-12 concentrations. Presented at Experimental Biology 2006.

Allen, L.H., Ramirez-Zea, M., Zuleta, C., Mejia, R-M., Jones, K.M., Demment, M.W., Black, M. Vitamin B12 status and development of young Guatemalan children: Effects of beef and B-12 supplements. Abstract submitted for presentation at Experimental Biology 2007.

LEAD PRINCIPAL INVESTIGATOR

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INCREASING ANIMAL SOURCE FOODS IN DIETS OF HIV-INFECTED KENYAN WOMEN AND THEIR CHILDREN

NARRATIVE SUMMARY

Animal source foods (ASF) such as meat, milk and eggs have been identified as key components in diets that build and maintain immune function and lean body mass and micronutrient status. Preliminary evidence suggests that improved nutrition for those infected with human immunodeficiency virus (HIV) early in the disease course, may delay progression to acquired immune deficiency syndrome (AIDS) and improve the effectiveness of anti-retroviral treatment.¹⁻⁴ Our long-range goal is to improve survival and enhance the quality of daily living for HIV and AIDS infected and affected people in Kenya as well as the growth and development of their children using food based solutions. The objectives of this research are (1) to demonstrate our ability to conduct a nutrition intervention trial in rural Kenyan HIV and AIDS clinics and (2) to evaluate the affect of ASF on disease progression of HIV-infected Kenyan women and the health and cognitive development of their children. The central hypothesis of the research is that a sustained intervention of this kind will result in maintained or improved nutrition and immune status, muscle strength, and lean body mass in HIV-infected Kenyan women and support the normal growth and development of their children. The rationale that underlies the investigation is that a diet with added ASF will provide the vitamin B-12 and lysine to maintain or significantly improve nutritional and medical status. Diets with added meat may show more favorable impact than those with added soy and those with no added protein due to the higher bio-availability of iron and zinc. This research is of interest to health professionals, agricultural research and extension personnel and policymakers worldwide.

Methods. Drug naïve, HIV-infected Kenyan

women (N=180) and one of their children will be followed for 12 months. The women will be recruited from the population already enrolled in the treatment clinic in the Turbo Division, Uasin Gishu District in Kenya that is managed by clinicians who are part of the Academic Model for the Prevention and Treatment of HIV (AMPATH).⁵ The women and their families will be randomly placed to either receive 1) meat biscuit, 2) soy biscuit or 3) no intervention food. It is yet to be determined if all families will receive supplemental staple foods during the 12 months of study. Assessments of nutrient intake and opportunistic illness will be monthly. Anthropometric, body composition, strength and quality of life assessments will be summarized every three months and biochemical measures obtained every six months.

RESEARCH

Problem Statement and Approach. Even with appropriate medical care that includes antiretroviral drugs, persons living with HIV & AIDS (PLWHA) are more likely to develop AIDS and die when poverty and food insecurity prevail. Low agricultural productivity is a direct consequence of HIV and AIDS especially in sub-Saharan Africa and results in nutritional deficiencies of energy, protein and micronutrients. Increased agricultural productivity will help to provide a reliable supply of a variety of foods in enough quantity that energy needs are met and protein intake is spared to support immune function and to maintain lean body mass. The increased availability of improved quality food; we hypothesize, will prevent or slow the progression of HIV disease. Impact can be measured from changes

in immune status, lean body mass, HIV viral load, work productivity, quality of life and mortality. The first step in this process is to determine if the daily addition of protein and energy to the typical plant based diet of HIV-infected rural Kenyan women and their children will prove beneficial. The addition of meat may prove more beneficial than soy due to the presence of vitamin B-12, bio-available iron and zinc and essential and conditionally essential amino acids. Those who maintain their muscle mass, near normal or slightly reduced cell-mediated immunity, and without the additional stress of infections, may respond more favorably to consistent and aggressive nutrition support and be better able to maintain health and quality of life, and to delay disease progression keeping them independent for as long as possible, at home able to care for and to teach their children^{1, 2, 6-8} and carry on activities of daily living. The rationale for including children in the study is based on the knowledge that those who are not HIV-infected are certainly affected when one or more of their parents are infected with HIV. These affected children are classified in the social sense as vulnerable for delayed development, dropping out of school, and stressed with becoming providers in the household; mainly for food. We hope to see if the physical growth and mental development and health of children (reduction of morbidity and if micro nutrient status and hemoglobin) can be improved or normalized. Previous work^{9, 10} shows that non-HIV-infected Kenyan children are at risk for delayed development and nutrient inadequacies that develop from inadequate energy and animal source foods (inadequate growth, iron and vitamin B-12 deficiencies). We will study the impact of adequate food in the household and further, the quality of the protein, on child growth and development. We will primarily focus on the development of children that are not HIV-infected; however will also follow siblings who are HIV-infected.

We intend the project to roll out in three phases:

Phase I will include a preliminary data collection to determine food availability over a 12 month calendar for a sub-group of 20 families in households similar, but not the same households as those that will be enrolled in the full 12 month protein

intervention study. This information is needed to determine if adequate food for energy is sufficient in these households and if not, to help determine if staple foods need to be provided to all participating households at any time throughout the 12 months of study. For example it may be determined that staple foods will only be required during the dry season. Other documents requiring institutional approval will be created during Phase I and will be submitted when completed through the Amendment process. Also during Phase I, the nutrient analysis of the protein intervention biscuits will occur, and staff will be hired and trained in measurement and assessment procedures for the various outcome variables.

Phase II will include a preliminary trial of all procedures with the approved data collection tools and trained staff in a population living in a different area than Turbo. These trial families (N=12) will not be eligible for inclusion in the 12 month protein intervention study population. Modifications to approved tools may be needed and changes will be made and forwarded for further institutional board approval via the Amendment process.

Phase III will be the full protein intervention trial that will include drug naïve, HIV-infected Kenyan women (N=180) and one of their children (N=180) who will be followed for 12 months. The proposed investigation is a 12 month randomized prospective study that will evaluate the effects of providing additional protein (meat or soy) and energy for 5 days each week in the diets of drug naïve and asymptomatic HIV-infected Kenyan women. The effect of the same intervention in the diets of one child in each of the families will also be assessed over the same time period. Randomization to a treatment cluster at baseline will designate one of three treatments to the HIV-infected woman and her designated child: (1) additional meat protein for 5 days each week over 12 months, (2) additional soy protein for 5 days each week over 12 months, (3) no additional protein supplement. At least 180 woman/child pairs (360 people) will participate in the study; 60 pairs in each of three group clusters (G). Each group will be managed with a different dietary supplement intervention as follows: (MG) added meat intervention, (SG) added soy intervention, (CG) control; no added intervention.

The protein intervention food will be delivered daily to the woman and her child by directly observed treatment (DOT) outreach worker. Any leftovers will be returned to a central location by the DOT worker and quantified. For 5 days each week, women will receive the equivalent of 21 grams of protein/day from either dried meat or heated soy powder and their designated child will receive the equivalent of 14 grams of protein/day from either dried meat or soy powder. The dried meat or soy powder are ingredients in biscuits that are standardized for quality and nutrient density. The biscuits will be baked from standardized recipes at a local bakery in Eldoret, Kenya, individually sealed and frozen in a commercial freezer. The dried meat will be manufactured and purchased from Farmer's Choice Butcheries based in Nairobi.¹¹ Farmer's Choice is a well known and reputable supplier of commercial meat products in Kenya. Food analysis of the products for macro and select micronutrients will be ongoing twice each year both in Kenya and in United States food analysis laboratories for quality and quantitative internal control purposes. Outreach enumerators will be specifically trained and will obtain baseline assessments and then longitudinal assessments of all the following methods. Nutrient intake and opportunistic illness will be obtained monthly. Anthropometric, body composition, strength and quality of life assessments and time allocation studies will be conducted every three months and biochemical measures obtained every six months. All participating families will receive donated treated bed nets at the beginning of the study and may receive staple foods on a weekly basis throughout the 12 month study depending on the results of the initial food security assessments. Women and designated children in all cluster groups will receive prophylactic treatment for helminthic parasites at baseline and every 6 months. All participating families will receive a pure bred dairy goat upon completion of the study.

To commence the research activities during FY 2006-2007, our focus during FY 2005-2006 was intended to establish project offices, hire key staff, and address any protocol design or assessment tool issues identified from a preliminary trial. Specific planned activities included: (1) Hiring and training field staff

in intervention and data collection methodologies, with standardization and quality control procedures (2) Submitting and receiving approval for any needed amendments to the institutional approval at Indiana, UCLA and Moi Universities, (3) Participation in required AMPATH HIV week of training for field staff, (4) Continued development and testing of intervention foods utilizing input from consultants, (5) Conducting a preliminary assessment of food availability and energy intake in a sub population, (6) Enrolling subjects for the preliminary trial and conducting the trial (7) Editing data collection and data entry forms per assessment from the preliminary trial, (8) Continuing to submit proposals for leveraged funding, (9) Purchasing the remainder of the equipment needed for the project implementation and transporting the equipment earmarked for Kenya, and (10) GPS mapping of the location of potential study families, recruitment and enrollment of identified eligible AMPATH families into the main nutrition intervention study and study roll out, and finalizing protocols, data capture forms and manuals for the definitive study.

Progress. The most important accomplishment of this first project year included modifications in the proposal design that reflect better control for the intervention and the establishment of project offices and the hiring of core staff. The project design now includes the treatment extended to provide the intervention food to women and children and possibly staple food for families for 12 months with the use of a directly observed treatment methodology to assure compliance with the intervention. The changes were critical, however the budget almost doubled to accommodate them. The current GL-CRSP project budget reflects costs for building infrastructure at Moi University, the intervention product development, the assessment equipment, a trial intervention, and the main nutrition intervention study and assessments for the first 120 women. The proposal was left intact to reflect the number (n=180) that is needed for statistical power. Leveraged funding sources will be sought for the remaining numbers of women needed, for the treatment and assessments of the target children, and for the biochemical analyses for nutritional

status and micronutrients for women and children, development assessments of the children and time allocation studies of the women.

Notification that the project was funded was communicated in February, 2006. Charlotte Neumann and Judith Ernst traveled to Kenya (Feb/March, 2006), to meet with collaborators to address the proposal modifications identified by the reviewers as needing modification. This trip was viewed as an extension of the planning grant phase and proved very helpful. Areas that were addressed include:

- Length of treatment – It was decided that the length of treatment should be 12 instead of 6 months to capture effects of the dry season on food availability for all participants.
- Assuring adherence – It was decided that the directly observational treatment (DOT) methodology that is successfully implemented in the treatment of tuberculosis, be employed to assure that intervention participants receive the intervention on a daily basis and that any uneaten intervention food can be quantified.
- Assuring uniformity of all groups with regards to the availability of food – It was decided that all study families, even those in the control group, receive the same amount of staple foods. The amount will be determined after a preliminary analysis of food availability in a sub-sample of families. It is important to make sure that the families have enough food available to them to provide enough energy so that the full effect of the intervention is captured.

Significant delay in executing the award to Indiana University (June, 2006) and subcontracts to Moi University and UCLA (August, 2006) prevented the ability to accomplish some of the planned activities in FY 06. We were able to:

- Set up temporary project offices and hire key field staff.
- The IU office was set up and a Research Grant Coordinator hired – Mrs. Wambui Mwangi.
- Two key staff at Moi University were hired.
- Logistics Project Coordinator – Mr. Z. Akula.
- Field Research Project Coordinator – Ms. Elizabeth Buluku.
- Some office furniture was purchased for the

project office at Moi.

- Submit the proposal to the institutional review boards at Indiana, Moi and UCLA and are awaiting approval from the institutions.
- Continue the development and testing of intervention foods.
- The meat biscuit recipe was developed and tested for nutritional value at Covance Laboratories, Madison, WI and acceptability with people in Kenya.
- The dried meat and soy flour were analyzed for nutritional value at Covance.
- The soy biscuit recipe was initiated and continues to be in development.
- Identify organizations where we will seek leveraged funding and are in communication with the grant organizations and for some of the organizations we have concept papers developed.
- A concept paper was submitted to the Nestlé Foundation and a proposal was invited. The submitted proposal for \$100,000 was rejected because the review board could not justify funding a comparison of meat with a superior protein source like soy protein. They could not discern that any difference would be detected but indicated that they would consider an alternative idea if we still used a food based approach.
- A proposal entitled “Impact of Animal Source Foods versus Plant Source Foods Feeding Interventions on Activities of Daily Living, Childcare, and Physical Work of HIV Positive Drug Naïve Kenyan Women: Time Allocation Studies” was submitted to the UCLA Globalization Research Center-Africa and funded at \$10,578.
- Purchase all the equipment needed for the project implementation and these were taken to Kenya by the PI and by the Co-PI during the August/September visit. Also equipment including quantitative food weighing scales, a length measuring board, skinfold calipers all valued ~\$1000 were donated to the project by the former Child Nutrition Project (GLCRSP-funded) that was carried out previously in Embu, Kenya.

The reality on the ground was different from what we had anticipated. Therefore, due to unforeseen circumstances, eg AMPATH and Moi University policies on hiring, and delays by the Institutional Review Boards (IRB), we were not able to achieve the following in the first year. However, plans are at an advanced stage to implement the activities within the first two quarters of the second year.

- Set up the Kenya office as earlier planned.
- Conduct a preliminary assessment of food availability and energy intake in a sub population.
- Enroll subjects for the preliminary trial and conducting the trial.
- Edit data collection and data entry forms per assessment from the preliminary trial.
- Submit research grant proposals to the Thrasher Research Fund, Cattleman Association and National Institute of Health.
- Conduct AMPATH training in HIV for research field staff
- Began initial training of Field Research Coordinator by former GL-CRSP CNP Coordinator Susan Nyerere.

GENDER

Study Population. In 2006, the Joint United Nations Program on HIV and AIDS (UNAIDS) reported that almost half of the adults living with HIV and AIDS today are women. Furthermore, the number of women and girls infected with HIV has increased in every region of the world and is on the rise.¹² This is most evident in sub-Saharan Africa, where close to 60% of adults living with HIV and AIDS are women. Our research project focuses on HIV-infected women of reproductive age in Kenya and their children. Reproductive age women and their young children are the most vulnerable population for malnutrition, HIV transmission, disease progression to AIDS and death in eastern and Southern Africa.^{13,14} Because of social, cultural and economic conditions, women's choice in sexual partners and protective practices are limited. Mother-to-child transmission is responsible for 90% of HIV infections among children under 15 years of age.

Improved nutritional status of reproductive aged women will impact infant morbidity and mortality. This project focuses on improving the quality and length of life of this most vulnerable population.

Solutions to the problems of poverty and hunger will be most effective and long lasting if the role of women in developing countries is addressed. Women play a vital role in the nutrition of developing countries and of their nation's people, producing much of the world's food. In eastern and Southern Africa about 75% of the labor for agricultural production is provided by women. If women are malnourished themselves or unable to feed their families because of inadequate resources or being too ill to buy food, the well-being of many others is jeopardized. If nutritional intervention can be shown effective in reproductive age women and their young children, the way is opened for further research to better identify and satisfy the nutritional needs of other HIV positive groups, e.g. older children, postmenopausal women, and men.

Research and field project staff. Of our two core project staff, one is male, Mr. Z. Akula (Logistics Project Coordinator), and the other is female, Ms. Elizabeth Buluku, MS (Field research Project Coordinator). The job descriptions for the other positions will not specify a particular gender as a requirement, and selections will be made based on qualifications of the applicants, not based on gender. We anticipate that we will have a mix of male and female applicants for the various staff positions that will need to be filled. We will be accepting applications from individuals who are graduate students and from those with at least a high school education. The two principal investigators (IU and Moi), the co-principal investigator, and the two consultants are all women. The two co-principal investigators (Moi) are men. Other Moi University faculty who are consulted on this project are the food technologist, a female, and the psychologist, a man.

POLICY

No contributions were made to policy as a result of the activities of year 2006.

Potentially the results of the proposed project

will begin to define more specific nutrition guidelines for HIV-infected and affected individuals because the research question is defensible. If this research shows or even suggests a positive impact on lean mass and/or immune function in HIV-infected Kenyan women and their children, the information can be the basis for policies that focus on adequate nutrition for women and orphaned and vulnerable children in Kenya. The existing draft of national nutrition guidelines for Kenya will probably not be implemented because the research background is not sufficiently well developed. AMPATH is represented in the National ART Task Force, a think tank composed of various stakeholders in the country. The Task Force is hosted by the National AIDS and STI Control Program (NAS COP - This is a Government body), and updates of the AMPATH program's activities are shared at each of the meetings. The Director of Kenya's National AIDS Control Program is on the AMPATH Advisory Board, specifically to enhance the policy implications of AMPATH's discoveries for all of Kenya, in addition to allowing the NACP to communicate directly with AMPATH's leadership. Therefore, AMPATH is represented in the National AIDS Control Council (NACC-the leading organization for combating HIV in Kenya) research committee, and may serve as a forum for dissemination of the study findings. Publication in peer reviewed journals will be the most powerful means of communication to both local and international policy makers.

OUTREACH

Given that this project is only in its initial phase, we have not accomplished any specific outreach activities. However, we will be carrying out focus group discussions in the community, and we will utilize community leaders to mobilize the community in participating.

DEVELOPMENTAL IMPACT

Environmental impact and relevance. Africa is the only continent in the world where per capita food production has declined during the last forty years, thereby resulting in a net loss in food self-sufficiency

ration from 98% in the 1960's to only 86% in the mid-1980's).¹⁵ Even if countries in Africa were food self-sufficient, national food self-sufficiency does not readily translate to micro-level food security.^{16, 17} In other words, even though a country may be able to import or produce enough food, accessibility at the local level may be difficult. It also does not guarantee food security at the household level.¹⁵ Women and children are prey to inequitable distribution of food within the household thereby making them particularly vulnerable to nutritional wasting and disease susceptibility.^{18, 19} Kenya is one of nine African countries hit hardest by HIV infection and AIDS. Because 75-80% of the labor force of Kenya is employed in agriculture, the pandemic has devastating economic and social implications leading to even greater food insecurity. In rural areas, the premature death of one or both parents results in decreased ability to purchase food, lost generational transfer of food production practices, and further malnutrition.²⁰⁻²⁴

This project targets the highest risk populations for nutrition inadequacy, women of child bearing age and children. John Owour, Head of the Food and Nutrition Unit of Kenya's Ministry of Finance and Planning, stated at the GL-CRSP conference in Nairobi, Feb 28, 2005 that nutrition is in the development agenda because the consequences of inadequate nutrition on productivity in Kenya are great. Fifty percent of people live below poverty; on less than \$1 per day and 80% percent of the population is dependent on agriculture. According to Owour, decreased access to food is one reason for increased mortality.

Protein energy malnutrition is the single cause of child mortality and 22% of children in Kenya under 5 years, are underweight. Murphy et al found the diets of 96% of children in Embu to be deficient in zinc, 90% in Vitamin B-12, 88% in calcium, greater than 50% in vitamin A, and greater than 30% in iron.²⁵ These nutrients are all provided from ASF. The GL-CRSP Child Nutrition Project showed that the only dietary measure that predicted performance was ASF, particularly meat.¹⁰ Stunting at 2 years is related to decreased cognitive development, which translates into productivity losses. The prevalence of anemia in women is 60% in pregnancy and 45%

in non pregnant women. Stunting, iodine deficiency and anemia translate to 61 billion Ksh in total productivity losses.

The AMPATH program at this time addresses the nutritional needs of only 20% of patients who are the sickest and the most food insecure by giving them food. Body mass index (BMI) is calculated for all patients and is the only nutrition assessment measure used at this time. The proposed project incorporates more sensitive indicators of nutrition assessment and body composition that may be determined as critical measures to predict treatment response. AMPATH is recognized as the leader in training for health care provided to PLWHA in western Kenya. If determined to be useful, these nutrition assessment and health indicators could be implemented as part of the overall care and potentially improve management and health outcomes for a large number of patients in Kenya.

Nutrition adequacy is both an input and outcome of development. Nutrition is the foundation on which the present generation secures a future for both itself and the next generation.²⁶ People who are well-nourished are more productive, are sick less often, and earn higher incomes. Nutritionally compromised people are less productive in their jobs and homes and in furthering their education. For this reason, the inclusion of nutrition objectives in growth and development policies holds the promise of potentially increasing the productivity and earning power of people world-wide.²⁷

Agricultural sustainability. The findings of this project will be the first step in the formulation of a novel, replicable, and transportable HIV and AIDS nutrition and agriculture model (see Heifer Project below) for implementation in resource poor areas, and that includes guidelines and interventions that prevent and limit health deterioration and increase food security within families and communities. Potential outcomes of this research will be improved health status for HIV-infected women and decreased numbers of orphaned and vulnerable children.

Heifer International will provide the in-country staff resources needed to provide training and animal distribution for this project. In the long term, they can assist in providing meat and other ASF through their Nairobi headquarters and field

offices in Western Kenya. They can mobilize livestock producers and related stakeholders and provide supply logistics, animal health and animal food resources and assist with the creation of market opportunities with farmers to support the project and build support at the community level for the objectives and adoption of best practices and sharing lessons learned that result from the knowledge gained.

Contributions to U.S. agriculture. At this time, the project offers no direct contribution to US Agriculture; however, it has potential to provide research opportunities for graduate students in the sciences. The knowledge gained related to the importance of meat as a necessary component to diets for HIV-infected individuals, will positively impact meat providers in the US as well as everywhere in the world.

Contributions to host country. The research project will contribute significantly to the country of Kenya:

- Increased infrastructure within the academic departments of Moi University that are involved in the research.
- Opportunities for academic training of Kenyan scientists.
- Opportunities for collaborative research for Kenyan faculty and staff from Moi University, governmental and non-governmental organizations that are involved in the research project.
- More in-depth nutrition assessment of HIV-infected women and their children living in rural western Kenya. The results of this proposed research may provide basis for nutrition intake and assessment guidelines for those living with or affected by HIV and AIDS, particularly in sub-Saharan Africa.
- Development of a strategy for sustainable production of ASF in rural Kenya..
- Practice-research collaboration in the areas of HIV and AIDS nutrition and market development for ASF among US and Kenyan Universities and a non-profit development agency like Heifer International. Effectiveness will be measured that documents assistance to women and children that results in improved

health, growth and development

- The findings of this project will be the first step in the formulation of a novel and replicable transportable HIV and AIDS nutrition and agriculture model for implementation in resource poor areas that includes guidelines and interventions that prevent and limit health deterioration and increase food security within families and communities.
- Moi university will own the patent of the intervention biscuits-Meat and Soy biscuits.

Linkages and networking.

- Collaboration with Moi University School of Agriculture & Biotechnology. Charlotte Serem, BED, MSc who is a faculty member in the Department of Family & Consumer Sciences in the School of Agriculture & Biotechnology, has proceeded with the development and testing of the recipes for the meat and soy intervention foods.
- Farmer's Choice Butcheries will be supplying the dried meat that will be incorporated into the intervention biscuits.
- Geoffrey Karanja, PhD from the School of Natural Resource Management, Moi University is assisting in the mapping of GPS points used for the randomization scheme and location of study participants.

Collaboration with international research centers (IARCS) and other CRSPs. This research project interfaces with one of the clinic populations that is managed by the AMPATH program and therefore is represented and included in the weekly agenda of the AMPATH research working group teleconferences between US collaborators and Moi University researchers. AMPATH is one of the care initiatives established since 2002 with USAID funds earmarked to provide antiretroviral drug therapy (ARVs) to HIV-infected persons in Kenya. Clinicians learned quickly that the nutritional status of HIV infected patients and food insecurity had significant implications for treatment response. AMPATH developed as part of the 15 year relationship between the medical schools of Indiana University and Moi University in Eldoret, Kenya, Uasin Gishu District (Rift Valley Province). Funding for AMPATH from the Gates and Rockefeller

Foundations and USAID President's Emergency Plan for AIDS Relief (PEPFAR) supports HIV and AIDS care clinics throughout Western Kenya with the goal of treating as many as 100,000 patients in the next few years. Presently over 30,000 patients are enrolled at clinics established in 15 clinic areas within 200 km of Eldoret, with approximately 800 new patients enrolling monthly. Approximately 50% of enrolled AMPATH patients receive ARVs as part of their treatment. The government of Kenya designated AMPATH as Kenya's primary training site for all of western Kenya.

OTHER CONTRIBUTIONS

Support for free markets and broad-based economic growth. If we find from the proposed research that meat proves beneficial in the diets of HIV-infected women and their families, we will investigate collaborative efforts with the solar drying Nutribusiness enterprise in Sotik, Bomet District that we visited during the planning grant phase as a strategy for dried meat production and sustainability. Another like enterprise is located in Majengo, Kenya. These cooperatives resulted from work led by Audrey Maretzki, Penn State University and with faculty from the University of Nairobi who trained local women to start and maintain a business that can also improve nutritional resources for families throughout the areas.^{28, 29} The cooperatives, involving nearly 2,500 women, were established to manufacture and market locally produced, culturally appropriate, nutritious and affordable food mixes for toddlers, while the women shareholders gained new, socially suitable opportunities for self-employment and income generation.

Contributions to and compliance with Mission objectives. Nutrition assessment and food-based interventions that may impact HIV disease progression have not been applied to the problem in Kenya. Our proposed project will provide new information that may have wide application for treatment and care of PLWHA. This is in direct alignment with USAID/Kenya health program mission objectives which focus on the provision of care and support for those already infected with HIV. Being a focus country within PEPFAR, the Kenya

country team is supporting a major expansion of HIV and AIDS programs, with special attention to care and treatment. A positive impact of the meat intervention in the short term will be interpreted if estimates of lean body mass, strength, indices of nutrition status, incidence of infection, measures of activity and CD4 are maintained or improved by the meat intervention in both women and their children.

Another mission objective of USAID is to identify and establish sustainable strategies to enable communities to cope with the needs of HIV-positive children and those orphaned by AIDS. Our project includes the provision of food to HIV affected families with outcome measures that will assess the impact of ASF not only on the health of the HIV-infected women but also of one target child in the household. Our findings that relate to the orphaned and vulnerable children can be applied in the development of sustainable initiatives for children.

Another mission objective is to reduce the impact of infectious diseases; focused primarily on strategies to prevent malaria and TB. The underlying science that supports this research question relates to maintaining immune function. Thus the knowledge gained can be translated directly to the non HIV-infected population who are at high risk for contracting infectious diseases.

Concern for individuals. The project is focused to benefit the population at highest risk for HIV-infection in Kenya, women of reproductive age and their children. What is learned will be extrapolated to benefit other populations as well in Kenya and throughout areas with high HIV prevalence.

Support for democracy. The promotion of democracy is exemplified in the focus of this project. The project is focused to benefit HIV-infected persons and their families. This population suffers from stigma and food/nutrition insecurity. What is learned will be disseminated to policymakers in the local, national and international communities and sustainable strategies will be developed. These strategies could be utilized as well in the US.

Humanitarian assistance. Currently, a significant percentage, (20-50%), of those infected with HIV in rural Kenya are food insecure. About

20% of patients enrolled in the AMPATH program receive food aid. The project that is proposed will initially focus on the impact of a food-based nutrition intervention for those individuals enrolled in the AMPATH program for HIV care, however are not receiving any food aid from AMPATH. All participating families will receive donated treated bed nets at the beginning of the study and may receive staple foods on a weekly basis throughout the 12 month study depending on the results of the initial food security assessments. Women and designated children in all cluster groups will receive prophylactic treatment for parasites at baseline and every six months. All participating families will receive a pure bred dairy goat upon completion of the study. If a participant who is randomized to the control group becomes eligible for food assistance, she will remain in the study and she and her family will receive the AMPATH standard of care food supplement and food intake will be assessed.

LEVERAGED FUNDS AND LINKED PROJECTS

Efforts to improve nutritional status in HIV-infected populations is a priority for the emerging Heifer Global HIV Strategy.³⁰ In return for their participation with the “Passing on the Gift” of pure bred dairy goats,³¹ Heifer International will enhance their understanding of the impact of meat and document to their board of directors and donors, reliability in the use of funds. This nutrition intervention study with meat will enable Heifer to adopt a more clinical approach with staff and partners in monitoring and measuring the potential benefit of meat in preventing disease progression.

- A grant from the UCLA Globalization Research Center in an amount of \$10,578 was awarded to support the time allocation studies of the HIV-infected women who will participate in the study.
- Faculty time spent on the project reported as in-kind as it is not supported in the project budget or in the cost share.

For Judith Ernst: \$20,490

October 1, 2005 - May 31, 2006 (25% time) = \$16,259

August 1, 2006 - September 30, 2006 (25% time) = \$4,231

For Charlotte Neumann: \$7,972

October 1, 2005 – June 30, 2006 (2.5% time) = \$2,314

Feb – March, 2006 in Kenya for 2 weeks at 100% = \$5,658

Charlotte Neumann, MD, University of California Los Angeles, child development and cognitive assessment

John Sidle, MD, Indiana University (Pediatrician) Liaison to AMPATH

Kara Wool-Koulstain, MD, Indiana University (Infectious Disease) Liaison to AMPATH

TRAINING

No degree training was initiated during this first phase of the project.

Short term: workshops, short courses

- Judith Ernst and Charlotte Neumann attended the Experimental Biology Advancing the Biomedical Frontier, April 1-5, 2006, San Francisco, CA.
- Judith Ernst and Charlotte Neumann attended the Moi University 2nd Annual International Conference Science and Socio-Economics for Sustainable Development: Challenges and Opportunities in the 21st Century (August 30 – September 2, 2006) Eldoret, Kenya and Dr. Neumann presented a paper from the Child Nutrition Embu project which was funded by GLCRSP.

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Barry Colley, PhD, Director of Enterprise Development & Global HIV Support, Heifer Project International

Judith A. Ernst, DMSc, RD, Dept. of Nutrition and Dietetics, Indiana University, nutrition assessment as it relates to children and HIV infection.

Audrey Maretzki, PhD Dept. of Food Science and Nutrition, Pennsylvania State University, dried food technology in Kenya

Suzanne Murphy, PhD, RD, University of Hawaii, diet analysis and nutrient databases

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David Ayuku, PhD. Clinical Psychologist, Dept. of Behavioral Sciences, Moi University, nutrition in relation to child development and cognitive assessment

Geoffrey Karanja, PhD, School of Natural Resource Management, Moi University, GPS mapping

Grace Keverenge-Ettyang, PhD, Dept. of Epidemiology and Nutrition, School of Public Health, Moi University, maternal micronutrient malnutrition and body composition assessment

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ABSTRACTS AND PRESENTATIONS

Experimental Biology Advancing the Biomedical
Frontier, April 1-5, 2006, San Francisco, CA.

Abstract

Gewa CA, Murphy SP and Neumann CG. Out-of-home reported foods in rural Kenya: a comparison of children's and mother's recall. April 2, 2006

Symposium: Food Based Approaches to Combating Micronutrient Deficiencies in Children of Developing Countries. April 3, 2006, Neumann CG (facilitator)

Papers

Neumann CG, Murphy SP, Gewa C and Bwibo NO. Meat supplementation improves micronutrient nutrition, growth, cognitive and behavioral outcomes in Kenyan children. April 3, 2006.

Moi University 2nd Annual International Conference Science and Socio-Economics for Sustainable Development: Challenges and Opportunities in the 21st Century (August 30 - September 2, 2006) Eldoret, Kenya

Neumann CG, Bwibo N, Grillenberger M, Gewa C. Meat Supplementation Increases Arm Muscle Area and Physical Activity Levels in Kenyan Children. August 31, 2006.

FOOTNOTES

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AVIAN FLU SCHOOL ASSESSMENT

NARRATIVE SUMMARY

Response to the current HPAI global animal health emergency requires the training of veterinarians, public health workers, laboratory scientists, livestock producers, wildlife and zoo managers, and government officials in emergency management, virus surveillance, sample collection and reporting, biosecurity, and disease containment. Currently, the numbers of trained responders is grossly inadequate to respond effectively to HPAI outbreaks in most parts of the world, particularly in developing countries.

The Avian Flu School Assessment developed an international train-the-trainer course covering the essential skills for prevention and detection of and response to an H5N1 highly pathogenic avian influenza (HPAI) outbreak. During the assessment period, three pilot courses were conducted: one at UC Davis (August 1-4) with international participants; one at Sokoine University of Agriculture, Morogoro, Tanzania (August 21-24); and one at Texas A&M University (September 11-14) with international participants. Participants provided evaluations of four course modules, and a critique of the course as a whole. The Assessment also included discussions with avian influenza coordinators and officials of government ministries, international nongovernmental organizations, universities and laboratories in Tanzania, Malawi, Uganda, and Kenya. In addition, we discussed the AFS course with the participants from Mali, Nigeria, Senegal, and Libya. The AFS course received very positive reviews from participants and observers from various agencies. The Assessment Team concluded that HPAI prevention, detection, and response training needs to occur at the national, district and village or community level.

Based on the work of the Assessment Team an international Avian Flu School curriculum is now ready for use in different countries and environments. Course materials and guidance documents for Avian Flu School are available at: www.avianfluschool.org.

RESEARCH

Overall Problem Model and Approach. The east Africa Region is host to about 300 million poultry and 287 million people. An estimated 60 to 70 percent of poultry in the region is kept under backyard or village-wide, free-ranging conditions. The region is also crossed by the Rift Valley corridor, a major flyway for migratory birds. The free-ranging poultry may be exposed to migratory birds, with the potential for HPAI transmission. Major rice production areas and wetlands in the region provide the opportunity for mixing between migratory and resident wild birds and domestic flocks. In addition, chickens and other poultry and poultry products are transported by buses and trucks across the region, providing many opportunities for virus transmission.

Response to the current HPAI global animal health emergency requires the training of veterinarians, public health workers, laboratory scientists, livestock producers, wildlife and zoo managers, and government officials in emergency management, virus surveillance, sample collection and reporting, biosecurity, and disease containment. Currently, the numbers of trained responders is grossly inadequate to respond effectively to HPAI outbreaks in most parts of the world, particularly

in developing countries. It is important to train district level veterinarians, public health workers, and agricultural extension staff, and to train people at the village level on measures to prevent and to respond to HPAI outbreaks.

Avian Flu School Assessment. To address the training needs related to HPAI, the Avian Flu School (AFS) Assessment (May-December, 2006) set out to:

1. Develop an effective international Avian Flu School curriculum
2. Pilot and evaluate the AFS Course
3. Launch a Web site to support AFS training

Activity 1: Develop an International Avian Flu School Curriculum

Progress. The AFS Assessment Project developed a course for veterinarians, public health workers, laboratory scientists, livestock producers, wildlife and zoo managers, and government officials. The

course curriculum was designed in a modular and lesson format to be adaptable to different countries and environments, and flexible to be tailored to the information and skills needs of different groups.

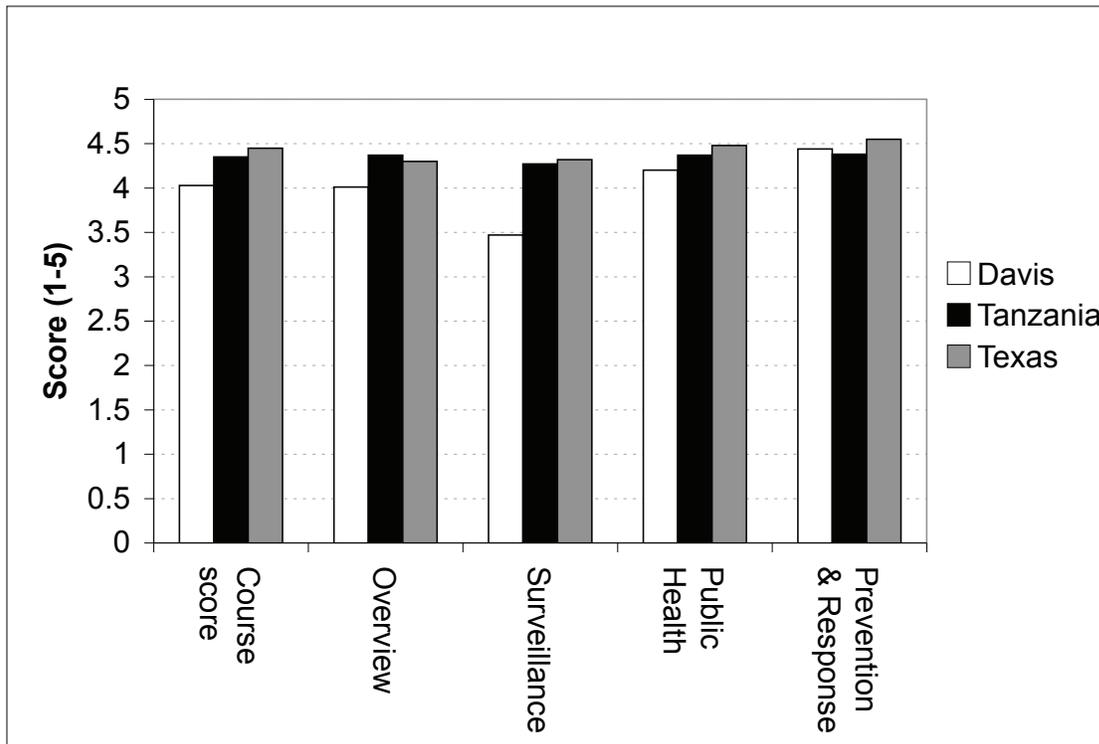
The complete AFS course is three days of workshops with short lectures and small group exercises, plus a half day of practical exercises. The classroom curriculum covers critical information for HPAI emergency management and communications planning, virus surveillance in domestic and wild birds, public health and worker safety, and HPAI prevention, detection, and response and recovery. In the laboratory session, participants practice using personal protective equipment (PPE), vaccination of domestic birds, swabbing and bleeding a chicken (or duck), and proper packaging for shipping of diagnostic and virus samples, and how to safely clean a chicken or duck. The course materials include illustrated handouts for important tasks.

The AFS course outline is presented in the table below.

Table 1. Avian Flu School Course Outline.

<p>Module 1: Overview (1 day)</p> <ul style="list-style-type: none"> •Introduction •Avian Flu Viruses •History of H5N1 HPAI •HPAI Transmission •H5N1 HPAI Risk to Humans •Impacts of H5N1 HPAI •Virus Surveillance, Testing, and Reporting •Coordination and Management of an HPAI Emergency •Communications Planning <p>Module 2: Surveillance (4 hours)</p> <ul style="list-style-type: none"> •Introduction •Surveillance of H5N1 HPAI: Steps, methods, types, and objectives •Sample size calculation •Surveillance in poultry and captive populations •Surveillance in wild birds •Developing an H5N1 HPAI Surveillance Plan <p>Module 3: Public Health and Worker Safety (2.5 hours)</p> <ul style="list-style-type: none"> •Introduction •General public education and protection •Poultry farm worker protection •Backyard/small holder poultry owner protection 	<p>Module 3 (continued)</p> <ul style="list-style-type: none"> •Live-bird market worker protection •Medical worker protection and patient protocol •Public health team protection •First responder protection •Healthcare worker protection <p>Module 4: Prevention and Response (1 day)</p> <ul style="list-style-type: none"> •Introduction •Prevention •Response •Recovery •Scenarios (Smallholder Poultry Operations, Wet (Live) Markets, Commercial Poultry Facilities, Zoological and Aviary Collections, Wildlife Refuges, Parks) •Developing Prevention Plans •Developing Response Plans <p>Practical Session (3 hours):</p> <ul style="list-style-type: none"> •Packaging a virus sample for shipping •Putting on and removing PPE •Cloacal and oral cavity swabbing for samples (1 person, 2 person) •Vaccinating a chicken •Bleeding a chicken •Safe slaughter and cleaning a chicken
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Figure 1. Overall Participant Evaluation Scores of the AFS Pilot Courses.



Activity 2: Pilot and Evaluate the AFS Course

Progress. The AFS Assessment Project conducted three pilot courses: one at UC Davis (August 1-4) with international participants; one at Sokoine University of Agriculture, Morogoro, Tanzania (August 21-24); and one at Texas A&M University (September 11-14) with international participants. The Assessment Project also organized discussions with avian influenza coordinators and officials of government ministries, international nongovernmental organizations, universities and laboratories in Tanzania, Malawi, Uganda, and Kenya. In addition, we discussed the AFS course with the course participants from Mali, Nigeria, Senegal, and Libya. Based on the evaluations from participants of the pilot courses and on comments and needs expressed in the discussions with avian influenza coordinators and officials, the course curriculum and training methods were honed and the training model was developed further.

AFS Course Received Excellent Evaluations. The AFS training program received very positive

evaluations at each pilot course. After each of the four modules, course participants were asked to fill out an evaluation form. At the close of each pilot workshop, the trainees participated in a facilitated discussion to critique and suggest improvements for any part of the curriculum and training methods. After each pilot course improvements were made to the course curriculum and exercises based on input from participants. The results of the pilot course evaluations are summarized in the figure below. Participants at each of the three pilot courses (Davis, Tanzania, Texas) were asked to rank each of the four modules on a scale of 1-5, five being best.

A Tanzania public health official that participated in the pilot workshop said, “I thought I knew a lot about avian influenza, but now that I have completed this workshop, I realize that I knew very little about it. But, now I feel I understand avian influenza. I believe it is important to conduct the AFS course for the public health community in Tanzania.” A veterinarian with the Veterinary Investigation Centre, who completed the Tanzania workshop, made a similar statement.

John Coakley, the USDA-APHIS coordinator for international avian influenza training, who participated in the Texas pilot course, said “I have been involved in training for over 20 years, and Avian Flu School is one of the best workshops I have ever participated in.”

The AFS Course Covers the Key Topics. Nations have prepared HPAI Preparedness and Response Plans according to the OIE/FAO guidance document on preparing such plans. At the Tanzania pilot workshop, we compared the AFS curriculum with the training needs identified in the Tanzania National HPAI Preparedness and Response Plan. AFS covers all the training subjects identified except one. The one exception was the training of technicians to conduct laboratory diagnostic tests for viruses. Other programs are focused on the training regarding laboratory techniques. By design, AFS is focused on the field training needs. (See chart below of the AFS course coverage of Tanzania national plan training

topics). The national coordinators, universities, and NGO officials we met with in Tanzania, Malawi, Uganda, and Kenya confirmed the AFS curriculum covered the important topics and they expressed strong interest in collaborating with the AFS program to conduct training workshops in their countries.

The AFS Assessment Project Concluded that HPAI Training is Needed at Three Levels. The AFS Assessment concluded that HPAI prevention, detection, and response training needs to occur at three levels or tiers:

- Tier I - is the training of instructors among existing professionals and national officials among public health and animal health public health ministries and veterinary service departments.
- Tier II - is the training of district veterinarians, agricultural extension staff, wildlife managers and public health workers.

Table 2. AFS coverage of Tanzania National Plan training topics.

Tanzania Plan Components	Avian Flu School Topic Coverage
Plan Background on HPAI H5N1	Module 1 Overview
Annex 3 Logical Framework	
Output 1 Capacity for Early Detection	Module 2 Surveillance
Output 2 Ability to contain AI	Module 4 Prevention & Response
Output 3 Reducing Human Infection	Module 3 Public Health & Worker Safety
Output 4 Increase Public Awareness	Module 1 Communications Planning
Output 6 Management & Coordination	Module 1 Coordination & Management
Annex 5 Implementation Schedule	
Training in 1st Year	Avian Flu School ready for 1st Year
Annex 6 Contingency Arrangements	
2.0 Response Actions	Module 4 Response Principles & Plans
2.2.5 Surveillance Activities	Module 2 Surveillance
2.2.6 Vaccination of flocks	Module 2 Module 4, Practical--Vaccination
3.2 Notification of Disease	Module 1 Reporting
3.3 Biosecurity	Module 4 Biosecurity principles & plans
3.6-3.8 Slaughter, disposal, disinfection	Module 4 AFS Handouts
4.0 Coordination & management	Module 1 Coordination & Management
Annex 7	
Project Organizational Structure	Module 1 Coordination & Management
Annex 8	
Flow Diagram for AI Outbreak	Module 1 Reporting Decision Tree

- Tier III - is the training at the village level, to be conducted by the district veterinarians, agricultural extension workers, or by field staff of other health networks.

The Tanzania Pilot Developed Approach for Village-Level HPAI Training. The Tanzania pilot course also discussed the challenges of preventing, detecting or responding to HPAI in village-level free-ranging poultry settings, where Newcastle disease is often endemic. Newcastle disease is a complicating factor for field diagnosis of HPAI because the clinical signs in chickens for Newcastle disease and HPAI are similar. The Tanzania workshop participants discussed and recommended the implementation of a village-level HPAI training program coupled with a viscerotropic velogenic Newcastle disease (VVND) vaccination program. The theory is that the improved chicken production at the village level due to the vaccination for Newcastle disease will be a strong incentive for village communities to participate in the HPAI training program. The increase in chicken productivity will also increase value of poultry to the community, increasing the incentive to prepare village biosecurity plans.

Activity 3: Launch a Web site to Support AFS Training

The AFS Assessment Project developed a Web site to support the organizing of course workshops internationally. The AFS Web site, at www.avianfluschool.org, provides the following:

- Guidance for organizing a training workshop
- Directions for ordering AFS course materials or a custom course
- Guidance for locating AFS instructors
- Recommended resources for instructors

GENDER

The AFS Assessment Team and participants in the AFS pilot courses included members of both genders. Carol Cardona led the Assessment Project as the Principle Investigator. Deana Clifford contributed to development of the Surveillance

Module. Sandy Shanks conducted background research and writing for the training materials. Twelve of eighteen participants of the Davis pilot course were women. Four of twenty participants of the Tanzania course were women. Eight of twenty-one participants of the Texas course were women.

In east Africa, typically women raise chicken flocks at the village level to provide protein for their families and to sell to earn some disposable income. Women and children are often the principal manager of small-scale and village-level poultry production. The Assessment Project concluded that training regarding HPAI must include methods that involve women in HPAI prevention, detection, and response planning at all levels.

POLICY

The results of the AFS Assessment have been shared with U.S. and international agencies, non-governmental organizations and ministry officials that are engaged in planning HPAI training workshops in the U.S. and abroad. Findings of the Assessment are being used to design efficient training programs to where funding is limited. Representatives of international agencies and national ministries that participated in the AFS Assessment pilot workshops have applied what they learned. Some participants have since organized HPAI trainings, and others have indicated their plans to include the topics of AFS curriculum in future workshops.

OUTREACH

AFS staff met with and provided updates to avian influenza coordinators and officials of government ministries, international nongovernmental organizations, veterinary universities, and laboratories in Tanzania, Malawi, Uganda, and Kenya. Outreach has included meetings representatives of the World Health Organization, the Centers for Disease Control and Prevention, the World Organization for Animal Health (OIE), the United Nations Food and Agriculture Organization, USAID Missions, and USDA-Animal and Plant Health Inspection Service. AFS has launched a Web site to provide updates

and support for the international community to plan and conduct HPAI training workshops (www.avianfluschool.org).

DEVELOPMENTAL IMPACT

Environmental impact and relevance. Improvements in poultry health and productivity will also reduce pressure to secure protein from wild sources thus contributing to better management of natural resources.

Agricultural sustainability. Poultry production is a key component of small farm production and maintenance of rural livelihoods. Animal disease threatens the sustainability of farming and the rural economy. AFS provides the skills to improve poultry health and productivity, and thus contributes to agricultural sustainability.

Biotechnology. The AFS project applies knowledge based on biotechnology research. Prevention, detection, and response principles have benefited from research on the ecology of viruses and the development of technology to identify, assess and study avian influenza, Newcastle disease, and other diseases. AFS provides the knowledge to apply the results of this research and technology development.

Contributions to U.S. agriculture. HPAI, exotic Newcastle disease, and other animal diseases are a threat to U.S. agriculture. In today's world of international travel and commerce, there is a constant threat of diseases spreading from other countries to the U.S. Thus, efforts to prevent and control diseases abroad reduce the likelihood that those diseases are introduced and afflict poultry and livestock in the U.S. agricultural sector. AFS contributes to preventing and controlling poultry diseases that could eventually spread to the U.S.

Contributions to host country. HPAI is one more disease afflicting people and domestic animals in the rural communities of Africa. The devastation of village chicken flocks directly affects the health and livelihood of people that depend on them for meat and eggs. The loss or low productivity of chicken flocks is particularly detrimental to women that raise them to feed their families and

rely on the sale of chicken products to earn some disposable income. The AFS program will increase the capabilities of national and district animal and public health officials and workers to prevent and control H5N1 HPAI in the countries where it is taught and applied.

Linkages and networking. Successful prevention, detection and response to HPAI requires a high level of collaboration between local, national, regional and international animal health and public health agencies and non-governmental organizations. The AFS Assessment Team has met with avian influenza coordinators and appropriate ministries and non-governmental organizations to solicit guidance and comments on the AFS curriculum, course design, and efficient methods to reach target audiences at the national, district and village level.

Collaboration with international research centers (IARCS) and other CRSPs. Future AFS workshops and research may be conducted in collaboration with international research centers and CRSP programs in various countries.

OTHER CONTRIBUTIONS

Support for free markets and broad-based economic growth. Disease in poultry and livestock decreases productivity in the agricultural sector and is a major barrier to commerce in these products. The principles of disease prevention and response as learned through the AFS program apply to avian influenza, exotic Newcastle disease, and other diseases afflicting domestic animals. Improvements in animal health are important for economic growth and market development in the agricultural sector.

Contributions to and compliance with mission objectives. The AFS program contributes to the Tanzania Mission's objectives for Economic Growth, Health, Education, and Environment and Natural Resources Management. Through AFS, improving poultry health will contribute to the productivity and economic value of poultry production. Rural families depend on poultry production for food and to sell to generate income. An increase in poultry health and productivity will directly benefit the rural family livelihoods. AFS is

an education program that provides information to empower families and poultry producers to improve their own economic conditions. Improvements in poultry health and productivity will also reduce pressure to secure protein from wild sources, thus contributing to better management of natural resources.

Concern for individuals. Individuals and families raise small poultry flocks for subsistence and for earning income. The methods and skills learned through the AFS program are for application by major poultry producers and by individuals maintaining small flocks. Individuals can improve their own flocks and livelihood by applying what is taught in AFS.

Support for democracy. Improving people's livelihoods strengthens democracy. AFS contributes to the health and economic well-being of families, poultry producers and the farm sector.

Humanitarian assistance. When HPAI outbreaks occur, it is an animal health emergency and an economic disaster for the rural and agricultural regions. A core component of AFS is to train poultry producers, field veterinarians, public health workers, and government officials how to prevent and effectively respond to such an emergency. The AFS course also provides training on how to protect public health and workers.

LEVERAGED FUNDS AND LINKED PROJECTS

The total value for leveraged funds for the AFS project during 2006 was \$206,820.61. The sources of those funds were as follows:

National Center for Foreign Animal and Zoonotic Disease Defense (FAZD) contract, support for the Avian Flu School (U.S.) project, May-September 2006, \$99,975.48.

GL CRSP-USAID (PCE-G-00-98-00036-00, Subgrant: 139-27-29), support for the Health for Animal and Livelihood Improvement (HALI) Rungwa-Ruaha Ecosystem project, August 2006-September 2008, \$106,845.13.

TRAINING

Non-Degree Training

Avian Flu School Pilot Course, four day workshop, August 1-4, 2006 at the UC Davis School of Veterinary Medicine in Davis, California (U.S.A.). Facilitated by Carol Cardona, David Bunn, Daniel Beltran-Alcrudo, and Michael Clifford. Objectives: HPAI overview, surveillance, public health and worker safety, prevention and responses, and practical skills session. Attended by 18 participants (6 male and 12 female).

Avian Flu School Pilot Course, four day workshop, August 21-24, 2006 at the Sokoine University of Agriculture in Tanzania. Facilitated by Carol Cardona, David Bunn, Daniel Beltran-Alcrudo, Michael Clifford, Deana Clifford, Peter Msoffe, Rudovick Kazwala, and Pete Coppolillo. Objectives: HPAI overview, surveillance, public health and worker safety, prevention and responses, and practical skills session. Attended by 20 participants (16 male and 4 female).

Avian Flu School Pilot Course, four day workshop, September 11-14, 2006 at Texas A&M University in College Station, Texas (U.S.A.). Facilitated by Carol Cardona, David Bunn, Daniel Beltran-Alcrudo, and Christian Sandrock. Objectives: HPAI overview, surveillance, public health and worker safety, prevention and responses, and practical skills session. Attended by 21 participants (13 male and 8 female).

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<http://www.au-ibar.org/>

<http://www.au-ibar.org/Site2/en/ibar/Events/BirdFluEng.pdf>

<http://www.au-ibar.org/EN/Insight/Summary.htm>

<http://www.cdc.gov/flu/avian/groups.htm>

<http://www.cdc.gov/flu/avian/gen-info/facts.htm>

<http://www.promedmail.org/pls/promed/?p=2400:1000>

http://www.fao.org/ag/AGAInfo/subjects/en/health/diseases-cards/special_avian.html

http://www.who.int/csr/disease/avian_influenza/en/Adult_education_articles

http://www.who.int/csr/disease/avian_influenza/guidelines/pandemicflu_protocol_17.03a.pdf

<http://www.oes.ca.gov/Operational/OESHHome.nsf/ALL/3D8DC8F9C9DCF2D688256FCB0065B847?OpenDocument>

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**HEALTH FOR ANIMALS AND LIVELIHOOD IMPROVEMENT (HALI)
IN THE RUNGWA-RUAHA ECOSYSTEM, TANZANIA**

NARRATIVE SUMMARY

The HALI project is a stakeholder-driven research and capacity-building program aimed at assessing the effects of zoonotic disease and water management on health and livelihoods in the Rungwa-Ruaha ecosystem, Tanzania. This biologically diverse and economically important region is seriously threatened by the seasonal drying of the Great Ruaha River. The primary drivers reducing flow in the Great Ruaha are uncontrolled agricultural water diversions that do not feed back into the river and intensive livestock grazing of wetlands. These processes have additive and interactive effects which have combined to cause the normally perennial Great Ruaha River to stop flowing and dry up for longer periods of time each year. We hypothesize that restricted water flow, degraded water quality, and increased interactions between livestock and wildlife species facilitate disease transmission and illness in livestock, wildlife, and people; reduced livestock productivity; and inadequacy of water for wildlife and hence reduced wildlife tourism potential. We have employed a stakeholder-driven participatory process to design an effective research and capacity-building program that will assess and mitigate zoonotic disease prevalence and the effects of water management on health and livelihoods. This project will serve as a model for other rural regions where water availability is diminishing and zoonotic diseases are important considerations due to high HIV/AIDS prevalence. Specifically our research will:

1. Determine the prevalence and transmission ecology of zoonotic diseases (diseases which can be passed between animals and people), including bovine tuberculosis, brucellosis, and water-borne pathogens among wildlife, livestock, and pastoral and agropastoral communities.

2. Assess the effects of water management and quality on the presence, abundance, and severity of disease.

3. Assess how water management and disease affect the health and economic livelihoods of agropastoral and pastoral communities.

4. Identify and recommend measures that will mitigate the effects of zoonotic diseases and water limitations on rural communities.

5. Strengthen the zoonotic disease education and research capacity of the Faculty of Veterinary Medicine at Sokoine University of Agriculture in Morogoro, Tanzania.

Results from this collaborative and participant-driven research program will inform management and policy to improve human, livestock, and wildlife health; facilitate economic development through improved livestock productivity and wildlife-based tourism; and strengthen local capacity to diagnose zoonotic disease problems and to design disease prevention programs.

This report covers the first three months (July-Sept. 2006) of the project. At our inception, we have focused on building the needed infrastructure in Ruaha (bush camp, solar electricity, transportation, communications, field laboratory, local working relationships, etc.) to implement the project activities, enhancing the structure of the HALI team, initiating the formal (one postdoctoral researcher and two Master's students) and informal training activities, and formalizing institutional relationships. There have been no changes to the research plan for the project. Overall, we are making satisfactory progress toward the original objectives in our plan, especially good progress given the short time frame since funding has been allocated (August 30, 2006).

RESEARCH

Overall Problem Model and Approach. The HALI project addresses complex disease and natural resources issues using the “One Health” paradigm, stressing that the health of domestic animals, wildlife and people are inextricably linked to the ecosystem and natural resources on which all depend (Osofsky et al. 2005). Diseases that can be passed between animals and people may be a significant barrier to improving human, domestic, and wildlife health in the Rungwa-Ruaha ecosystem. The presence of disease in this ecosystem (Wilson 2003) and the potentially far-reaching consequences of disease at the human-livestock-wildlife interface have been recognized (Bengis et al. 2004), but the scale of the problem has not been assessed and solutions have not been developed.

For example, recent surveillance indicated that approximately 80% of cattle sampled in Usangu Game Reserve (UGR), adjacent to Ruaha National Park (RNP), were exposed to bovine tuberculosis (Iringa District Livestock Office, unpublished data). Interestingly, RNP sightings of buffalo (*Syncerus caffer*), a species sensitive to bovine tuberculosis (BTB), have declined by approximately 70% over the past 16 years, and they have shown a dramatic collapse in their local range (WCS unpublished data). Prevalence of BTB has not been assessed for wildlife in RNP, but BTB was recently discovered in multiple wildlife species in protected areas of northern Tanzania (Cleaveland et al. 2005). Thus its role in the observed buffalo decline needs further study. The combination of high BTB prevalence in livestock, lack of information in wildlife, and a large HIV/AIDS-infected local human population represents a potential human health disaster. Specifically in Tanzania, about 60% of the increase in the notification rates of human pulmonary tuberculosis during 1991-1993 and 1996-1998 were associated with HIV infection (Range et al. 2001).

In addition to direct health impacts, disease undermines the marketability of livestock through frequent quarantines and lowers productivity through morbidity and mortality, especially in drought years. Tanzania’s livestock production is exceptionally low, with meat production only 4%

of Sub-Saharan Africa, despite harboring Africa’s 3rd largest national herd. Per-capita calories from animal products are 18% lower than the rest of Sub-Saharan Africa and 73% lower than the rest of the world (Trends 2003). These numbers not only affect the local availability of protein (Demment et al. 2003; Neumann et al. 2003), but they also affect Tanzania’s development trajectory by undermining its ability to market its livestock products internationally. Poor livestock productivity due to disease also fuels the wild bushmeat trade, thereby impacting biodiversity and degrading wildlife tourism potential (Brashares et al. 2004).

Water Management. The costs of water disruption are significant and far-reaching. First, pastoralists that have traditionally used the Great Ruaha River to water livestock have been forced to find other sources. Water restriction has decreased the area available for grazing and increased the concentration of livestock using dwindling water sources. Pastoralists report that this process has increased disease transmission at water holes and has led to decreased forage quantity and quality. However, the effect of these factors on herd productivity has not been quantitatively assessed. Another major cost of river drying has been the loss of wildlife tourism potential, both for RNP and for the village-managed Lunda-Mkwambi Pilot Wildlife Management Area (LMPWMA). Tourism in this part of Tanzania is concentrated in the dry season, when wildlife is visible near perennial water. The spatial distribution of surface water has declined over 60%, leading to a comparable decline in high-potential area for tourism. This reduction in wildlife viewing area is particularly significant for village economies struggling to diversify their economic base beyond livestock and rice production (Walsh 2000).

Interaction of Water and Disease. Transmission of BTB and other diseases may increase with reduced water availability, as people, wildlife, and livestock are increasingly forced to share dwindling and lower quality water sources. In South Africa, buffalo herds with higher rates of bovine tuberculosis had increased sensitivity to drought and endoparasites and more rapid loss of body condition during the dry season (Caron et al. 2003). With the drying of the Great

Ruaha River, the spatial distribution of buffalo has declined nearly 33% in the GRR portion of the Park (WCS, Aerial buffalo count, 19-20 October 2004, unpublished data), compressing herds into a smaller area where potential for disease transmission is higher and forage competition is more severe. The risk of disease is likely to increase as water quality is diminished through increased fecal contamination and stagnation of the remaining dry season watering holes.

Participatory Process to Define the Problems.

United States Agency for International Development Sustainable Agriculture & Natural Resource Management Collaborative Research Support Programs (USAID-SANREM CRSP) planning funds were used to explore the problems and research needs surrounding large-scale linkages between agriculture and biodiversity in the Rungwa-Ruaha ecosystem. First, participatory pastoralist focus groups were organized to clarify the problems and check assumptions. Semi-structured interviews and male and female focus groups allowed community respondents to discuss the important issues and ensured that culturally-appropriate research and disease/development intervention methods would be proposed. The goals of the participatory process were to: 1) highlight the socio-economic circumstances of pastoralist and agropastoralist households; 2) identify the rough division of labor among men and women, and age classes, with respect to animal husbandry, water, and disease management; 3) explore pastoralists' perception of disease issues, their drivers, and what can be done to mitigate the effects of disease on livestock, livestock productivity, and human health; and 4) establish the extent to which risk-factors identified elsewhere in Tanzania are realized in the Rungwa-Ruaha ecosystem.

Our visits revealed that most pastoralists draw water directly from rivers or shallow wells, as they often live too far from developed water sources. Respondents also indicated they are sometimes forced to draw water from the same sources as livestock when usual water sources become dry. Perceptions about disease and actual disease risk may differ by gender; men make most livestock management decisions (including healthcare) and women attend to daily husbandry needs (milking,

calf management, tick removal). Accordingly, women may be important sentinels for recognizing livestock disease. Women may be exposed more frequently and be at higher risk for disease transmission because of their more regular and close contact with livestock (particularly cattle), and livestock products (mostly milk, meat, fat and occasionally blood). Additional information is detailed in our SANREM planning grant report (webpage link: <http://www.vetmed.ucdavis.edu/whc/sanrem.cfm>).

In order to strengthen institutional and local-level linkages, a two-day workshop on July 25-26, 2005, linked experts from University of California, Davis and Wildlife Conservation Society, Tanzania National Parks, the Iringa District Veterinary Office, and Sokoine University of Agriculture to local stakeholders, which included wildlife managers (specifically the natural resource management Association for the 19 villages in Lunda-Mkwambi pilot Wildlife Management Area; MBOMIPA), and local livestock extension officers. Small group and plenary sessions examined the potential for disease interactions to affect livestock population dynamics, livestock productivity, human livelihoods, human health, wildlife populations, and tourism possibilities.

Participants agreed that the highest priority diseases for study were pathogens that: 1) are impacted by water use issues, 2) may severely affect human health (especially individuals with HIV/AIDS), 3) adversely affect livestock health and productivity, and 4) threaten the persistence of endangered species. Specific disease agents adhering to these criteria included tuberculosis (human, bovine, and atypical strains), brucellosis, rabies, and water-borne bacteria and parasites.

An overwhelming consensus emerged from diverse stakeholders including pastoralists, multiple levels of government, non-profit organizations and academia: a significant proportion of the rural population in the Rungwa-Ruaha landscape is affected by water-related diseases, and these diseases are affecting health, agricultural productivity, food security, and biodiversity in the Rungwa-Ruaha ecosystem.

Considering the problems described above and the needs for research as defined through the local

community meetings and the stakeholder planning workshop, the HALI project seeks to:

- Assess the prevalence and transmission ecology of zoonotic diseases among wildlife, livestock, and pastoral and agropastoral communities. These research results will inform the design of disease prevention programs and management decisions.
- Assess the affects of water (river and other water bodies) management on the presence, abundance, and severity of disease impacts. These research results will be used to inform the development of water management strategies to improve the health of livestock and pastoral and agropastoral communities and the health of wildlife and the ecosystem.
- Assess how water management and disease affect the health and livelihoods of agropastoral and pastoral communities. The results of this research will provide estimates of the economic costs of disease-related water management decisions in order to support water management decisions that minimize disease and improve livelihoods.
- Identify and recommend measures that will mitigate the effects of zoonotic diseases and water limitations on rural communities.
- Strengthen the zoonotic disease education and research capacity of the Faculty of Veterinary Medicine at Sokoine University of Agriculture (SUA), Morogoro, Tanzania. This project will increase local capacity to investigate zoonotic diseases, respond to disease events, and develop disease prevention programs.

Implementation involves sampling and testing domestic animals and wildlife, sampling and testing water, data analysis, epidemiological modeling and analyses, and impact assessments. During research activities efforts will be made to engage community stakeholders, local people, and policy-makers so that appropriate recommendations, interventions and training activities can be developed as results become available.

Activity One: Commencement of the HALI Project

Progress. The objectives for this activity were to: 1) obtain proper research permits in Tanzania, 2) obtain an institutional Animal Care and Use Protocol at the University of California, Davis, 3) identify new Tanzanian students and project staff, and 4) relocate expatriate team members D. Clifford (postdoctoral researcher) and M. Clifford to Tanzania. A research proposal and permit application were submitted to both the Tanzanian Wildlife Research Institute (TAWIRI) and the Tanzania Commission for Science and Technology (COSTECH) by D. Clifford on 4 July 2006. Professors Kazwala and Kambarage from Sokoine University of Agriculture (SUA) sponsored Dr. Clifford's proposal. The Conservation Resource Centre (CRC) in Tanzania facilitated the permit application process through both government departments. The Tanzanian Wildlife Research Institute (TAWIRI) approved the HALI project research proposal on 28 September 2006. COSTECH approved the permit on 16 October 2006. The animal care and use protocol #12394 submitted by J. Mazet and D. Clifford to the University of California Davis, Animal Care and Use Committee on 12 July 2006 was approved on 24 August 2006. Two Tanzanian veterinarians, Julius John and Annette Kitambi have been selected by Dr. Kazwala to participate in the project and use the research as the bases for Masters degrees at Sokoine University of Agriculture. Hildegard Aloyce has also been hired as the primary research assistant. It is our hope to transition the management of the HALI project to complete Tanzanian management in the long-term. Unfortunately, because of the remoteness of the study site, severe living conditions, extremely tight timeline (only 2.25 year project), and lack of trained Tanzanians in zoonoses of wildlife and livestock, we were not able to recruit Tanzanian leadership for the field portion of the project. This deficit in available scientists was recognized before support from the GL CRSP was solicited, and an expatriate field lead, Deana Clifford was identified. Our goal is for Dr. Clifford to collaborate with the faculty of Sokoine University of Agriculture and other team members to build the capacity necessary

for the project to transition to Tanzanian leadership both at the University (existing) and in the field (goal). Dr. Clifford and her husband M. Clifford arrived in Tanzania on 9 August 2006 to immediately begin this process, as well as rapid data collection.

Activity Two: Preparation for implementation of zoonotic disease testing of livestock, water sources and wildlife

Activity Three: Preparation for implementation of the assessment of the impact of water management and disease on the health and livelihoods of agropastoral and pastoral communities

Progress. The objectives for the first three months of this activity were to 1) finalize the selection of sampling sites and identify participating households for livestock disease sampling and socioeconomic work, 2) create the capability to run appropriate diagnostic tests for disease both in the field and at SUA, 3) to initiate sample collection for those samples for which the team already holds permits or for which none will be required, and 4) begin compiling a spatial model of livestock and wildlife distribution.

Drs. Peter Coppolillo and Deana Clifford began the selection of sampling sites on 18 August 2005. The HALI project will partner with a new “Community liaison” project of the Wildlife Conservation Society’s Rungwa-Ruaha Living Landscapes program (leveraged funds) to work with study villages for disease sampling and socioeconomic work (Activity 3). As part of this effort specific people in each of the villages will be linked with a HALI project team member (Mr. Ayubo Omari Msago) so that disease cases or outbreaks will be reported immediately.

During the first week of September 2006, Mr. Bakari Mbano met with officials from the village association responsible for managing the Lunda-Mkwambi wildlife management area (MBOMIPA) in order to obtain permission for the HALI project to collect samples from wildlife species legally-hunted in the region. The MBOMIPA association has approved our request and given HALI team members permission to train community game scouts in safe

collection of tissue samples from hunted wildlife. On 28 September 2006, Dr. Deana Clifford, Mike Clifford, and several Rungwa-Ruaha program staff members trained 18 MBOMIPA game scouts in safe tissue collection and storage. As part of their job, game scouts routinely handle blood and tissues from hunted animals. Our training served to educate the scouts about diseases they might contract from their job, and also gave scouts practical advice and supplies (latex gloves) so that they can lower their risk of contracting a zoonotic disease from the animals with which they work. As a result of this process, samples have been collected from impala, buffalo, and eland. Given the political sensitivities surrounding hunting of wildlife species in Tanzania, Mr. Mbano’s successful efforts on behalf of the HALI project are to be commended. Not only will these samples provide valuable data, but the training opportunity is an important step for helping to ensure the health of those working with hunted wildlife. It will also serve as the community’s first introduction to the HALI Project, which will serve to promote collaboration and transparency among hunters and the village-association (MBOMIPA) responsible for regulating hunting in the study area.

Drs. Clifford, Coppolillo, and Kazwala met with Dr. Vitarus Lyaruu from Tanzanian National Parks to discuss the possibility of collaborating on an upcoming planned capture of at least six buffalo inside Ruaha National Park. Given TANAPA’s expertise in wildlife capture, this collaborative disease surveillance effort on the wild species most likely to be infected with bovine tuberculosis is an exciting opportunity to sample live wild animals inside the park to try to determine if bovine tuberculosis is present within the park. HALI project assistance will likely enable more animals to be captured and more pathogens to be tested on samples collected. This capture will also serve as an opportunity to train veterinary students from SUA. It is anticipated the capture will occur in October or November of 2006.

Spatial data that is currently being compiled by HALI team members in the Community Liaison Program (A. Msago) are being used to help finalize sampling sites and identify participating villages and households. The output will be a finalized list of

sites for disease sampling in livestock, wildlife and water, and a list of participating households for the disease and socioeconomic work. This data will also contribute to the spatially explicit model of livestock density that will assess overlap with observed wildlife distributions. This aspect of the project will be supervised by P. Coppolillo with consultations from our team members from SUA, TANAPA and TAWIRI in regards to the wildlife distributions. The outputs from this model will preliminarily identify points of maximum disease transmission potential, based on pastoral household locations, water points and observed wildlife distributions. To ensure stakeholder involvement during project activities, D. Clifford will also be introduced to District, Division and Village Authorities. Completion of these activities is anticipated for early next year.

Activity Four: Identify and recommend measures that will mitigate the effects of zoonotic diseases and water limitations on rural communities

Progress. This activity will proceed after the data collection phase. All of the data collected will be used to assess the health and socio-economic impacts of disease in light of the larger watershed management and environmental concerns. The approach to research these relations will involve a spatial data analysis of the economic and environmental drivers of disease infection rates. Geo-referenced data from this study and from economic, environmental, and public health sources will be collected and used to develop an appropriate model framework for examining the socio-economic determinants of watershed health and disease in the Rungwa- Ruaha ecosystem. This analysis will provide data-based recommendations for mitigation measures to be implemented at all levels from animal husbandry to water policy.

We are currently seeking funding to support innovative outreach to effectively distribute our recommendations at the community level. We have the commitment from a world-renowned collaborator, Theatre for Africa, to develop community theater using local pastoralists and stakeholders as actors to boost the implementation of recommendations. Unfortunately, funding for this process has yet to

be identified. Similarly, given adequate funding, we plan to deliver strong natural resource policy recommendations using a quantitatively based model for disease assessment and for exploring different disease and water management scenarios using empirical data. Should we identify funding for additional years of the project, this modeling work will be completed to allow natural resource managers and policy makers to explore mitigation measures in a relative cost-benefit framework.

Activity Five: Strengthen the zoonotic disease diagnostic capacity and educational capacity at Sokoine University of Agriculture, Tanzania

Progress. As part of this long-term activity to strengthen the zoonotic disease diagnostic and educational capacity at SUA, our first short-term objective was to draft a memorandum of understanding between the University of California - Davis, Tanzanian Wildlife Conservation Society, and Sokoine University of Agriculture in order to facilitate the working relationship between the participant organizations for this project, another GL CRSP-funded project in progress (Avian Flu School, PI-Carol Cardona), as well as future expansion of research and capacity building activities. Principal HALI team members P. Coppolillo, D. Clifford and D. Bunn, R. Kazwala, and D. Kambarage met on 24 August 2006 at SUA in Morogoro, Tanzania, to discuss the framework for an agreement. A consensus from the meeting emerged to craft a broad MOU that would build on the strengths of all three organizations in zoonotic disease and animal health. Prof. Kambarage from SUA has prepared the first draft of the MOU. D. Bunn has drafted language for the UC Davis portion.

Additionally, D. Clifford, R. Kazwala, and M. Clifford have been meeting regularly to discuss project logistics, budgetary processes, and to identify potential students for the Masters in Preventive Veterinary Medicine Program (MPVM) at SUA. Two Tanzanian veterinarians, Dr. Julius John and Dr. Annette Kitambi, have been selected as MPVM students supported by the project. We are making satisfactory progress on both our capacity and educational objectives. All institutions are eagerly

moving towards a more formal collaborative structure for research and capacity building that has grown from our initial collaboration on the project.

GENDER

Our commitment to gender diversity is evidenced by the composition of our team members. Female team members, Jonna Mazet (Lead-PI), Deana Clifford (TZ project coordinator/postdoctoral researcher), and Woutrina Miller (water-borne pathogens) from the University of California, Davis; Hellen Ngowi from Sokoine University of Agriculture; and Dee McAloose from the Wildlife Conservation Society, will bring senior expertise and mentorship to the project. To help address the paucity of female academicians in Tanzania, we have identified a promising female veterinarian, Annette Kitambi, to conduct MPVM research on this project. Additionally, we have employed a female field research assistant, Hildegard Aloyce, for the socioeconomic research in order to ensure our methods are gender appropriate and that accurate data reflecting gender differences are collected.

One of the most significant areas to be explored in the HALI project is the gender-related division of labor and their potential relationships to disease exposure, transmission and prevalence. Maasai, Barabaig, Sukuma and Gogo pastoralists are all present in the area, and gender roles vary significantly among these groups. Familiarization visits and informal interviews will complement survey work and allow more time to assess gender-segregated activities. Through these methods we will obtain a more detailed account of the gender differences in disease exposure within each ethnic group.

POLICY

Results from the HALI project are anticipated to have direct relevance to policies in Tanzania regarding public and animal health, poverty alleviation, and natural resources. Tanzania's current Veterinary, Water and Wildlife Policies are being reviewed as part of initiating research activities, but no direct policy interventions occurred during the first three months of the HALI project. As part of establishing

the project and implementing our work, we will look for the opportunity to engage policy-makers and discuss the upcoming work. Additionally, we have been and will continue to regularly update the USAID Tanzania Mission as part of our efforts. Policy outreach is planned for the third year of the study once data have been evaluated.

OUTREACH

Informal outreach activities will be facilitated through the local village-association (MBOMIPA) responsible for community-based land management, and other local NGOs such as the Southern Highlands Livestock Development Association (SHILDA) and the Rungwa-Ruaha Living Landscapes program of the Wildlife Conservation Society. We held a one-day informal training course for 18 MBOMIPA game scouts on how to safely process the carcasses of hunted wild animals. Training materials were developed by Prof. Kazwala from SUA and Deana Clifford. Game scouts were informed in Swahili by Rungwa-Ruaha program staff members about precautions they can take to reduce their occupational risk of disease exposure from hunted wildlife. The scouts were also taught how to record the location of a hunter-kill using hand-held Global Positioning System (GPS) units and how to take pictures of carcasses using digital cameras. Acquiring knowledge about health precautions and a basic skill set to monitor hunter-killed animals, has allowed the game scouts (most of which have only primary school education) to be active participants in health surveillance for hunter-killed wildlife. Data collected by the scouts regarding how many animals are hunted and where they are hunted will also be used by MBOMIPA to monitor its resident hunting program and plan future land management activities. Outreach to game scouts was conducted first, as these scouts may be at risk of contracting disease from wildlife during their normal working activities, and because the hunting season was already underway when HALI project team members arrived in the field.

The results of our disease testing and socioeconomic work will dictate the goals of future outreach activities at the local level. Optimally we will target activities at the most at-risk groups

identified by our research activities and use a combination of formal workshops, produced materials and informal visits to achieve outreach goals. We anticipate our outreach materials will be applicable to other regions facing similar health problems. As mentioned above, we are also currently seeking funding to support innovative outreach to effectively distribute our recommendations at the community level with our collaborator, Theatre for Africa. In the U.S., the project has been featured in outreach materials (newsletters) aimed at raising the awareness about the role of zoonotic diseases in health and economics.

DEVELOPMENTAL IMPACT

Environmental impact and relevance. Diseases that can be shared by people, domestic animals, and wildlife are a challenge to biodiversity conservation and environmental sustainability. Diseases spread from domestic animals to wildlife can threaten the persistence of species through direct mortality or by making animals more vulnerable to predation or other environmental perturbation. Furthermore, disease contributes to livestock losses and poor productivity, which in turn contributes to the continuance of poaching wildlife for a source of protein. These conflicts are heightened in communities that border protected areas, as these rural communities are often poor, rely heavily on livestock keeping, have little access to health care, and often have little stake in the protected area itself. As community conservation initiatives increase in scope, complex disease issues that emerge at the interface of wildlife, domestic animals and people must be taken into account when planning land management strategies and ensuring access to natural resources for people and animals.

The HALI project is extremely relevant as it is one of the first projects to assess complex disease and natural resource issues at the wildlife-livestock-human interface. Information about the presence or absence of zoonotic diseases in wildlife, livestock, and their shared water sources will assist both Tanzanian National Parks and the neighboring community wildlife management area under the jurisdiction of MBOMIPA in managing their natural resources. These findings are not only applicable at

a local level but can be used to advise approaches for health in other community-based management systems in Africa. This need for health research at the wildlife-livestock interface has been identified as an important part of the South African Development Community's Biodiversity Conservation Strategy (SADC Biodiversity Support Program 2006). Additionally, findings from HALI will be used to improve the health of livestock and thereby reduce the need to poach wildlife for food security.

Agricultural sustainability. High stocking densities of livestock not only lead to environmental degradation through overgrazing of marginal habitats, but also enhance disease transmission thereby contributing to poor animal health. The HALI project hopes to promote sustainable agricultural practices by improving the health of livestock and promoting sustainable herd sizes. In addition, water policy recommendations emanating from the HALI project and collaborating efforts will provide data-rich models for evaluating livestock sustainability in areas where natural resource preservation practices may fuel conflicts at the livestock-wildlife interface.

Biotechnology. The HALI project uses advanced diagnostic methods in combination with locally-based field research to assess the ecosystem level effects of disease and water management on animals and people. As much of the disease diagnostic work as possible will be conducted in Tanzania using recent advances in field diagnostic kits, and by using modern disease diagnostic methods such as polymerase chain reaction (PCR) techniques at Sokoine University of Agriculture. Although logistically difficult at times, developing in-country capacity to conduct zoonotic disease testing will result in a more sustainable development program and enable Tanzanian universities, such as SUA, to address ongoing health problems more effectively.

Contributions to U.S. agriculture. Emerging zoonotic diseases are important in all regional contexts and in the global economic market. Understanding the issues of disease transmission among wildlife, livestock, and people is key to limiting agricultural and natural resource conflicts in the United States. One excellent example of how information from this project will benefit the U.S.

is the application to the current controversy in the Greater Yellowstone Area concerning potential brucellosis transmission from bison and elk to privately owned cattle surrounding the Park. Our data will be directly applicable to this issue, and the natural resource management recommendations will likely translate very easily. In addition, our data will contribute to the understanding of zoonotic disease morbidity and mortality in people with HIV/AIDS. Finally, our results will likely provide data on the implications of water resource management on disease and livelihoods in any rural community. This information can be used domestically, as well as in future international aid investments. In addition, U.S. researchers will benefit from the expertise of Tanzanian collaborators and the infusion of novel ideas and progressive zoonotic disease investigative approaches currently underway at SUA.

Contributions to host country. Tanzania will benefit most immediately through increased capacity for laboratory diagnosis of zoonotic diseases at SUA. Diagnostic equipment and supplies will be purchased and available for use because of the HALI project, and SUA's diagnostic laboratory capacity will be expanded by the per sample analytical funding. The collaborative relationships and technology transfer will expand the diagnostic services available and the ability for Tanzania to develop novel diagnostic and research methodologies. This collaboration has already made significant impacts in Tanzania. For example, prior to our implementation the Tanzanian government was unaware that PCR capabilities existed in Tanzania. Now SUA's diagnostic laboratory has been elevated in esteem from a university service to a regional resource for advanced diagnostics for diseases like avian influenza. Similarly, the Faculty of Veterinary Medicine will benefit from collaborative studies and the introduction to new research partners and methods. The funding of two students and their projects will, at the minimum, provide important research results from Tanzanians on issues that have local implications and international impact potential, and at the maximum, may also produce two new faculty members for the University.

On the broader scale, our findings should have direct relevance to poverty reduction strategies in Tanzania. Improving health and livestock

productivity, as well as optimally managing water resources, has country-wide benefits. If zoonotic disease transmission can be reduced, Tanzanian health and welfare will improve and associated costs decreased. Similarly, improved livestock health will result in increased productivity and income. Water management improvements could have significant impacts on the country for agricultural growth, as well as reduction of electricity losses currently prevalent in the dry season.

Linkages and networking. The HALI project is developing strong linkages with the USAID Tanzania Mission, as well as the Animal Health for the Environment and Development (AHEAD) initiative led by the Wildlife Conservation Society. By linking with other programs working with AHEAD, results from the HALI project can be disseminated to a global network of professionals involved in health and development work. HALI is also solidifying its linkages with Tanzanian National Parks, the Tanzanian Wildlife Research Institute and the Division of Wildlife so that project activities benefit the needs of these government agencies within Tanzania.

Collaboration with international research centers (IARCS) and other CRSPs. The pilot phase of the HALI Project was funded by the Sustainable Agriculture & Natural Resource Management (SANREM) CRSP and explored the problems and research needs surrounding large-scale linkages between agriculture and biodiversity in the Rungwa-Ruaha ecosystem.

We have been unsuccessful at engaging an IARC partner despite multiple attempts to do so. We are hopeful that our success on the ground will stimulate involvement from the International Livestock Research Institute (ILRI) in Nairobi, Kenya. Indications to date are that involvement has not been possible because of limited resources at ILRI rather than a lack of interest in the project. We also have begun exploring linkages with human health researchers in the public health sector; we are hopeful that these collaborations may also result in IARC partnerships. The community level disease assessments of the HALI project are also linked with another GL CRSP funded initiative focused on training people for Avian Flu Preparedness.

OTHER CONTRIBUTIONS

Support for free markets and broad-based economic growth. As mentioned above, animal disease undermines the marketability of livestock locally and globally. Disease also limits agricultural development by lowering overall productivity (morbidity and mortality), especially in drought years. Similarly, the costs of water disruption are significant and far reaching. Water restriction has decreased the area available for grazing and increased the concentration of livestock using dwindling water sources. This process has also led to increased disease transmission and decreased forage quantity and quality. Tanzania's livestock production is exceptionally low, despite harboring Africa's 3rd largest national herd. Per-capita calories from animal products are substantially lower than the rest of Sub-Saharan Africa and drastically lower than the rest of the world (Trends 2003); therefore, improved productivity and trade outlets are likely to present opportunities for economic growth.

Poor livestock productivity due to disease also fuels the wild bushmeat trade, thereby impacting biodiversity and degrading wildlife tourism potential (Brashares et al. 2004). Wildlife tourism potential has also been impacted by river drying, both for RNP and for the village-managed Lunda-Mkwambi Pilot Wildlife Management Area (LMPWMA). Tourism in this part of Tanzania is concentrated in the dry season, when wildlife is visible near perennial water. The spatial distribution of surface water has declined over 60%, leading to a comparable decline in high-potential area for tourism. This reduction in wildlife viewing area is particularly significant for village economies struggling to diversify their economic base beyond livestock and rice production (Walsh 2000).

Contributions to and compliance with Mission objectives. The HALI project is well integrated with other USAID development efforts including the Tanzania Mission. The proposed activities are in line with the Mission's Environment and Natural Resources, Economic Growth, and HIV/AIDS Strategic Objectives designed to encourage livestock productivity, participatory landscape conservation, sustainable use of natural

resources, and wildlife health and wildlife-based tourism. The Mission was extremely supportive of this initiative and provided a strong letter of support that was submitted with the proposal.

Concern for individuals. The HALI project is focused on two key determinants of individual health and livelihoods, animal health and water availability. Knowing the extent to which zoonotic diseases are present in the livestock and water sources that rural people depend upon is an essential first step towards improving the health and livelihoods of individuals in this region of Tanzania. Additionally by better understanding the impact of animal disease and water availability on the lives of traditionally marginalized pastoralists and agro-pastoralists, we can raise awareness regarding their potential contributions to strategies for overcoming obstacles facing Tanzania's economic development.

Additionally, HALI places high importance on human capital, thus we are committed to training individuals both through academics and outreach. In our first three months of the project, we have trained 18 game scouts to reduce their occupational exposure to zoonotic diseases, and two Tanzanian veterinarians are starting their Master's degrees.

Support for democracy. The stakeholder-driven community-based approach of the HALI project will serve as an example of democratic process. Working with the local village-association and village-based governments to manage local resources and improve animal and public health through participatory planning will help to improve local governance.

Humanitarian assistance. Disease affects people's quality of life not only through direct mortality, but also through reduced productivity and therefore livelihood reductions. HIV and tuberculosis often effect people in their prime working years and together have a devastating impact on family stability. Our project seeks to maximize animal health and thereby reduce the transmission of chronic debilitating diseases such as tuberculosis and brucellosis from animals to people.

LEVERAGED FUNDS AND LINKED PROJECTS

The total value for leveraged funds for the HALI project during 2006 was \$153,000. The sources of those funds were as follows:

GL CRSP-USAID, Avian Influenza Response Instructor Training Program-Tanzania Pilot Program with Carol Cardona as project PI, May 1, 2006-September 30, 2006, \$150,000.

Wildlife Conservation Society-various private donations, Rungwa-Ruaha Living Landscapes Program with Peter Coppolillo as project PI, 2003-ongoing, \$3,000.

TRAINING

Degree

John, Julius. Tanzanian, M, Sokoine University of Agriculture, Preventative Veterinary Medicine, MPVM.

Kitambi, Annette. Tanzanian, F, Sokoine University of Agriculture, Preventative Veterinary Medicine, MPVM.

Non-Degree

One day short course on guidelines for safely handling wildlife carcasses and consuming meat products from wildlife, September 28, 2006 at the Wildlife Conservation Society Field Camp-Lunda Mkwambi pilot Wildlife Management Area, Tanzania. Facilitated by Deana Clifford, Michael Clifford, and Bakari Mbano. To teach game scouts how to reduce their risk of zoonotic disease exposure while conducting their jobs by giving them practical guidelines for how to properly handle tissues or blood from wildlife carcasses, and for consumption of meat from wildlife, disseminate knowledge about zoonotic diseases of concern when working with wildlife, including information on how to recognize signs in wildlife, and lastly to teach practical field skills including digital photography and use of hand-held global positioning systems to monitor community-based hunting efforts. Attended by 18 participants (18 male).

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PUBLICATIONS AND ABSTRACTS

No publications, abstracts or presentations have been produced to date, as we are in the inception phase of the HALI project (only three months have passed).

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**GOBI FORAGE – FORAGE MONITORING TECHNOLOGY
TO IMPROVE RISK MANAGEMENT
BY HERDERS IN THE GOBI REGION OF MONGOLIA**

NARRATIVE SUMMARY

The GOBI FORAGE project represents an expansion of the existing Livestock Information Network and Knowledge System (LINKS)/GLCRSP project with the goal of applying forage and animal monitoring technology developed in the Livestock Early Warning (LEWS) phase of the program to pastoral communities in Mongolia. The project addresses rural business development by adapting proven LEWS/GLCRSP monitoring technologies so that they can be used by Mongolia's livestock producers. The objectives of this project are to: 1) develop a forage monitoring system that provides near-real time spatial and temporal assessment of current and forecasted forage conditions for Mongolia livestock producers; and 2) develop an information and communication infrastructure along with an analysis delivery system to provide herders with information on current and forecasted forage conditions in the Gobi region of Mongolia. The program has 4 major research activities including: 1) infusion of forage monitoring technology to assess regional forage quantity; 2) infusion of the Near Infrared Reflectance Spectroscopy (NIRS) nutritional profiling technology for assessing diet quality; 3) information delivery and outreach; and 4) linking GLCRSP technology for forage quality and quantity monitoring into herder alliances. These technologies will provide timely information on forage conditions to increase lead time for making risk mitigation decisions by herder groups and policy makers. Nutritional profiling to assess and manage livestock performance will be integrated with the forage monitoring technology via other funding sources (Mercy Corp-USDA) to enable herders to make business decisions that enhance profitability within an array of livestock

enterprises. Information delivery and outreach components include dissemination of information via maps, radio, news bulletins, and internet. This information is provided to people at the local, regional, and national levels. Incorporation of the LEWS/GLCRSP technologies into organized herder alliances will enhance decision making, improve livestock marketing, and allow these groups to better manage risk. The activities associated with this project are being pursued in collaboration with Mercy Corps under the umbrella of the USAID funded GOBI II Initiative.

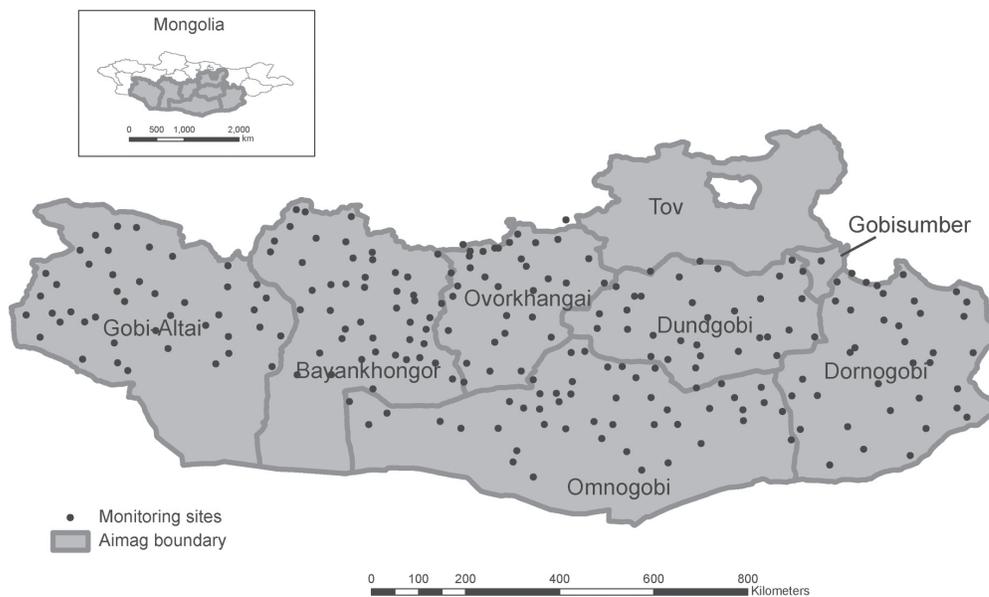
RESEARCH

Activity 1: Infusion of Forage Monitoring Technology

Problem Statement and Approach. Drought and winter disasters represent a major risk confronting herders in Mongolia. 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 is being pursued. Our objective is to develop a forage monitoring system that provides near-real time spatial and temporal assessment of current and forecasted forage conditions for Mongolian livestock producers.

Progress. The establishment of monitoring points for the early warning system was conducted in two phases. In Phase I, monitoring points were established in the Gobi Altai, Bayankhongor, and Ovorkhangai aimags (Figure 1) during May to September 2004. Phase II monitoring sites were

Figure 1. Location of the livestock early warning system monitoring sites within the Gobi region of Mongolia.



established in the Dundgobi, Omnogobi, and Gobi-Sumber aimags (Figure 1), during May to September 2005. The Phase I and II efforts resulted in the establishment of 211 monitoring points in these 6 aimags (Figure 1). In 2005, an additional 36 monitoring sites were added in the Dornogobi aimag (Figure 1), using leveraged funds from the World Bank Khulan (Asiatic wild ass) Study. During this reporting period, 55 new monitoring points were established in the Tov aimag (Figure 1), using leveraged funds from the World Bank Sustainable Livelihoods Program. In total, 302 monitoring sites are now established in the Gobi Forage Livestock Early Warning System.

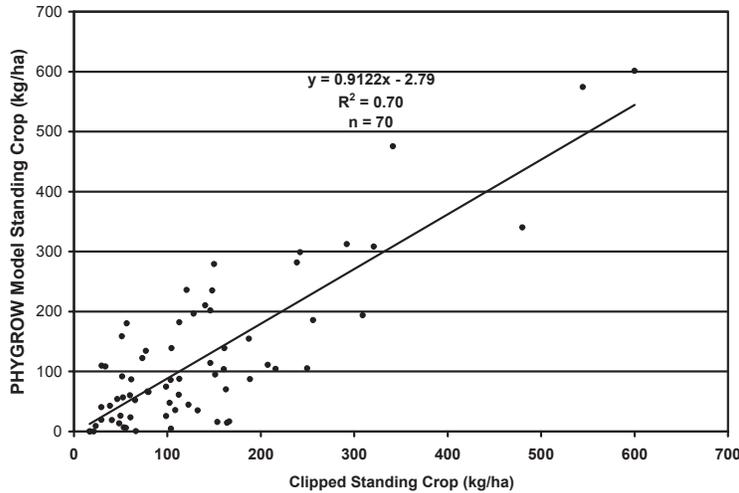
During the fiscal year, work in this activity has been focused on calibrating PHYGROW model runs for the Phase II monitoring sites, verification of the model outputs, and development of the regional mapping products. PHYGROW parameterization data collected at the monitoring sites has been entered into the simulation modeling system, calibrated, and is now part of the automated monitoring system. In order to assess the accuracy of the model output and the regional mapping products, verification sampling has been conducted at the monitoring

sites (Figure 2). In summer 2005, verification data was collected at a subset of the monitoring sites in the Phase I aimags. An analysis was conducted to compare the model output standing crop to that clipped at the monitoring site. Results of this analysis indicated a very reasonable correspondence between the model output and the forage clipped at the site ($R^2 = 0.70$; Figure 3). Problem sites were identified and model runs were recalibrated. These sites were

Figure 2. Field crew sampling vegetation at one of the monitoring sites in the Gobi region of Mongolia.



Figure 3. Regression analysis of the clipped standing crop versus the PHYGROW forage model standing crop at the monitoring sites sampled for verification in 2005.



revisited in summer 2006 to revalidate the model outputs for the sites. Also during summer 2006, verification sampling was conducted at a subset of the Phase II monitoring sites. These data are currently being summarized and will be analyzed before the beginning of the 2007 field season, so that any problem sites can be identified and resampled.

During both summer 2005 and 2006, forage standing crop data was collected at randomly selected sites across the 6 aimags (Figure 4), to assess the accuracy of the regional forage maps created

using geostatistical cokriging of model output and satellite greenness (NDVI) data. To date, data have been collected at 167 points across the region (Figure 4). These data are currently being summarized, and map accuracy assessments will be conducted prior to the start of the 2007 field season.

During field visits in summer 2005, and in the subsequent analysis of verification data, it was discovered that the CMORPH rainfall product used as a driving variable in the PHYGROW simulation model was over-estimating actual rainfall in many portions of the study areas. We worked with the Institute of Meteorology and Hydrology in Mongolia and NOAA to acquire ground station data in order to assess the differences and explore bias correction methods. We were able to receive data for approximately 200 weather stations in and around Mongolia. We examined the degree of differences between the station rainfall and CMORPH estimates, and looked at various bias correction methodologies (local, regional, and temporal) to correct the data. The corrected rainfall data from each of the bias correction methodologies was run

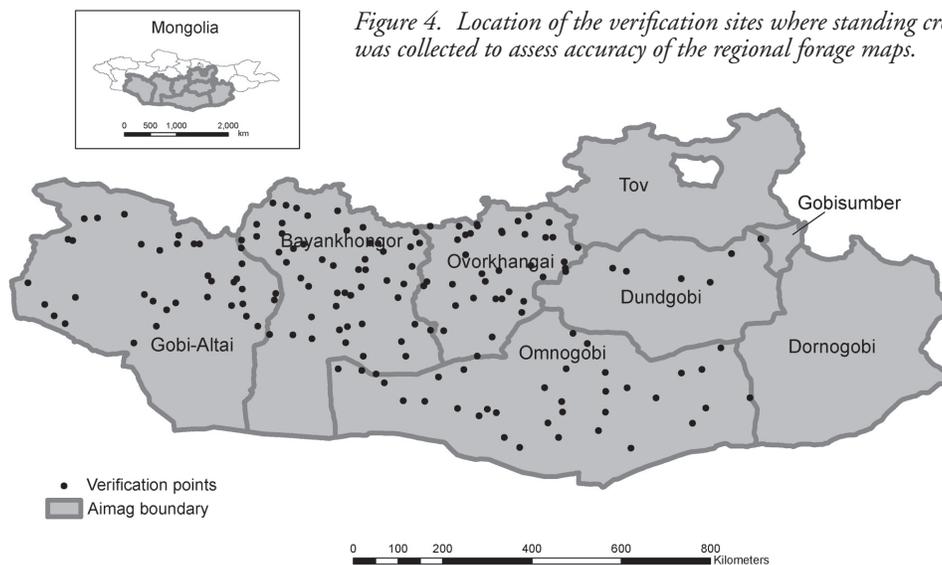


Figure 4. Location of the verification sites where standing crop data was collected to assess accuracy of the regional forage maps.

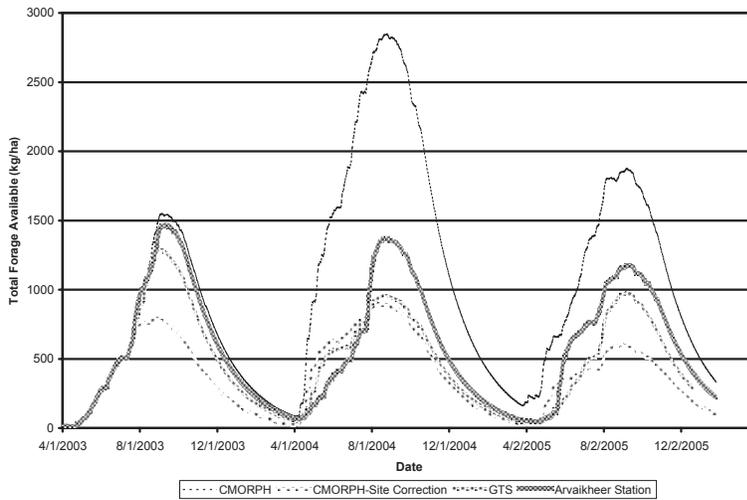


Figure 5. Comparison of methods for correcting CMORPH rainfall data and its impact on PHYGROW forage simulation model output. The CMORPH line represents the actual CMORPH data reported by the Climate Prediction Center. The CMORPH-site correction line indicated a bias correction method derived from the historical data for that site or station. The GTS line represents a bias correction using data from 200 Global Telecommunications System (GTS) stations on a daily basis. The Arvaikheer station line indicates the actual station data collected at this site. The model output with the GTS correction had the best correspondence to that of the actual rainfall run through the PHYGROW simulation model.

through the PHYGROW model to determine which method resulted in standing crop values that were most similar to the standing crop produced by the model when the actual station data was used (Figure 5). The results indicated that a daily bias correction incorporating the regional data from the 200 stations was most similar to station data. This bias correction was added to the automated system so that the correction is done on a real-time basis.

Once the problems with the rainfall had been addressed, we began producing regional forage

maps. These maps included current total forage available, 60 day forecasted total forage available, forage deviation from long term average (for both current and forecast), and total forage difference from the previous 15 days. The maps are designed as diagnostic tools for assessing current conditions, rate and direction of change from previous conditions, and a 60 day forecast of statistically probable conditions. The first maps for the region were produced during early June 2006. Since then, the maps have been produced bimonthly, following the

Figure 6. Total forage available deviation from long term average for the Gobi Region of Mongolia. This represents the English version of one of the maps produced for use in the early warning system. A Mongolian language version is also available.

June 1 to June 15, 2006

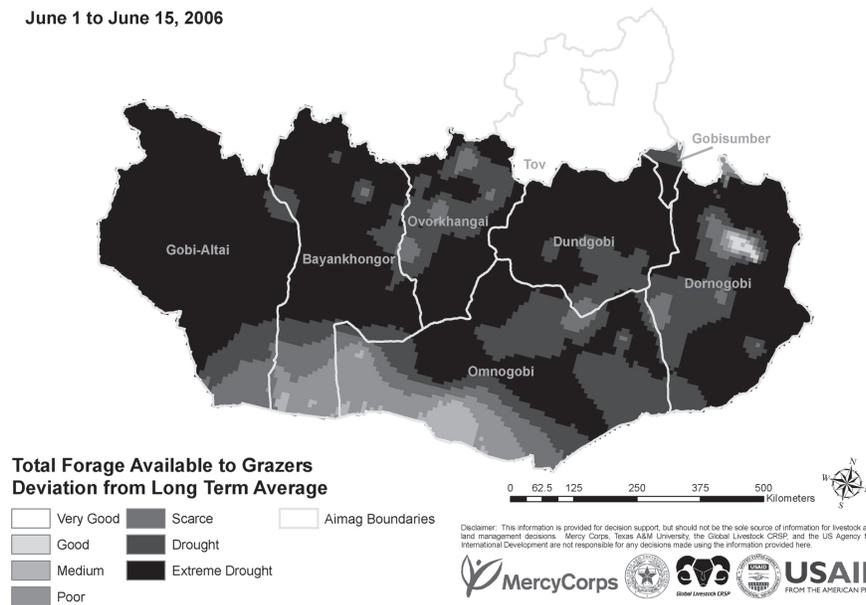


Figure 7. Drought stricken area in the Dundgobi aimag in early June 2006.



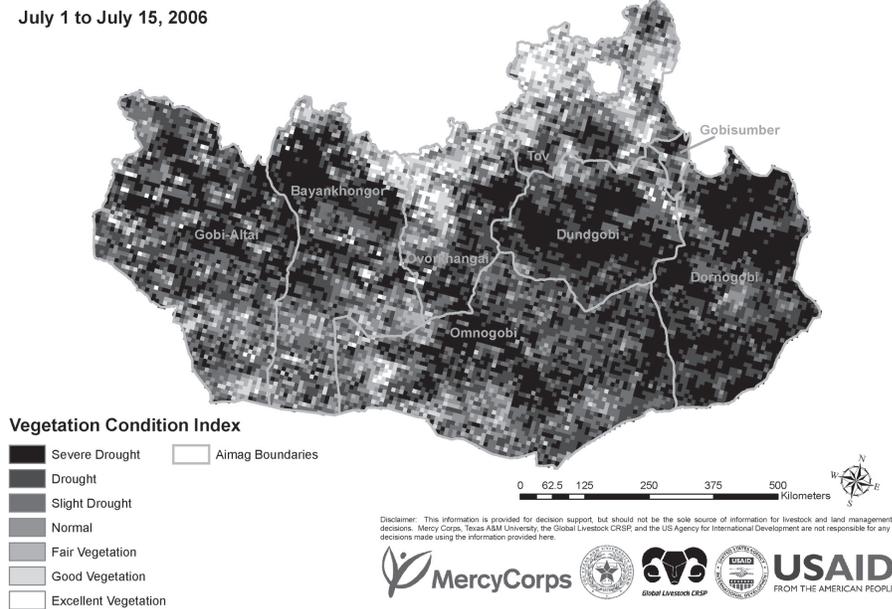
cycle of NDVI image production. During early June 2006, the maps indicated a significant area of drought in the Dundgobi and Gobi Altai aimags (Figure 6). We traveled to the Dundgobi aimag and conducted verification sampling at several of the monitoring sites in the area of drought depicted on the map. The area was indeed in drought, and there was very low biomass at the majority of the sites we visited (e.g., Figure 7). We interviewed a few herders in the region and they indicated that most of the

herders had moved out of the area because of the low forage conditions. Data collected during this sampling are currently being analyzed for quantitatively assessing accuracy of the map.

Several value-added products are currently being produced that will add to the diagnostic capabilities of the early warning information. These include the Vegetation Condition Index (VCI; Figure 8) and the Rainfall Deficit Maps. The VCI is an index derived entirely on Normalized Difference Vegetation Index (NDVI) data. The NDVI for the current period is scaled according to the historical minimum and maximum for a pixel, and the index reflects where the current pixel falls along this scale. Current pixels that are scaled very close to the minimum are defined as severe drought. Rainfall

deficit maps provide an indication of how much the current rainfall lags behind the long-term average for an area. This provides users with an understanding of the current rainfall deficit (if any) to gauge the intensity of a drought. These two products, when combined with the forage map products, can provide analysts who are preparing bulletins or radio reports with additional information to confirm data produced by the forage monitoring system.

Figure 8. An example of the vegetation condition index (VCI) map produced for use in the early warning system in Mongolia.



Activity 2: Infusion of the NIRS/NUTBAL Nutritional Management System

Problem Statement and Approach. In addition to drought and winter disasters, herders in Mongolia have no information on nutritional deficits or opportunities for inputs of supplements to help them transfer from a subsistence to entrepreneurial system of production. The major limitation is the lack of monitoring technology for them to make this transition in order to understand how to best graze forage resources and input strategic nutrients. Our specific objective for this activity is to develop a nutritional monitoring system for sheep, goats, cattle, yak, horses, and camels that provides assessment of nutritional balance, changes in body condition and optimal fodder interventions for Mongolia livestock producers.

Progress. This activity was funded by Mercy Corps via USDA Wheat Monetization funds. The study area covers the area around Ulaanbaatar, and areas with cattle, sheep, goats and yak in the region north and west of Ulaanbaatar, along with overlap into regions within the Gobi Forage Study area (Ovorkhangai and Bayankhongor aimags).

A three-phase plan has been employed to test and implement the fecal NIRS/NUTBAL system in Mongolia. This includes: 1) determining how well the current U.S. - based fecal NIRS equation suite predicts diet quality in Mongolian livestock; 2) determining how well the portable NIRS system recreates performance of the static NIRS system, and how well it performs on new diet:fecal (D:F) pair calibrations; and 3) determining how well the current iteration of NUTBAL nutritional balance software predicts performance of Mongolian livestock.

Preliminary diet:fecal pair studies have been completed for 56 animals including sheep, goats, horses, and yak in collaboration with the Agriculture University of Mongolia and Research Institute of Animal Husbandry (RIAH). A preliminary NUTBAL validation study with cattle and yak has been completed in cooperation with a herder in the Arkhangai region. In August 2006, a total of 1,726 samples from the diet:fecal pair studies, which included 1,045 fecal samples, 392 diet orts samples,

and 264 diet samples were shipped to the Grazingland Animal Nutrition Laboratory (GANLAB) at Texas A&M University for further scanning and analysis. In addition, several hundred geo-referenced fecal samples of all livestock species have been collected opportunistically by the forage sampling teams. At this time, all fecal, diet, and ort samples are being analyzed at Texas A&M for chemical and bench top NIRS analysis, and to determine compatibility with current NIRS diet quality equations.

During this reporting period, a feeding trial with two phases of 16 days took place involving eight three-year-old horses. Sixteen types of diet rations were used in the experiment to evaluate the nutritional value of fodder for Mongolian horses. Additionally, this trial will help to develop Mongolian diet:fecal calibrations for NIRS. From the trial, 132 samples were collected, including 4 diet, 32 ration, 32 ort, and 64 fecals.

In order to expand project activities in the local areas, equipment (a laboratory grinder, an oven, a vacuum cleaner, and a fan, with a combined value of MNT 7,826,274 [USD 6580]) was shipped from the US and installed at the RIAH research station in Ikhtamir soum of Arkhangai aimag. A training on proper use of the transferred equipment was provided to the station staff members. The equipment will be used to conduct further feed trials and NIRS trials under field conditions. A planned trial at the camel research station in the Omnogobi aimag was postponed during this fiscal year due to drought. These conditions made it impossible to collect enough forage to create the diet combinations needed for equation development. This trial will be resumed during FY2007 if conditions are favorable. During the August 2006 visit to Omnogobi, a plan was developed to conduct training on an alternate procedure for diet:fecal pair collection with browsing animals in sparse vegetation. If drought continues, this procedure would allow creation of camel fecal NIRS equations.

The first completely Mongolian derived NIRS equation is now under development. Fecal samples collected during July and August were dried, ground, and scanned with the portable NIRS machine. The samples are currently being analyzed at the RIAH laboratory for further nitrogen analysis. Professors

at the Mongolian State University of Agriculture were contacted to undertake statistical analysis of data generated from the NIRS fecal sample scanning using SPSS statistical software. This relationship will facilitate creation of the multiple regression models needed to achieve portable NIRS predictive equations for fecal nitrogen.

A NIRS/Nutbal animal performance study was conducted in Arkhangai during 2005/2006. Data on body condition scores of Mongolian cattle and yak, and their physiological change over the past six months have been entered into the NUTBAL software with assistance of yak and cattle researchers. This data will determine the ability of the current Nutbal software to monitor animal performance under Mongolian conditions, and suggest areas of improvement for future research efforts.

Equation development during this reporting period was slowed by problems with shipping samples from Mongolia to the US. New Homeland Security requirements and changing regulations at USDA resulted in an approximate 6 month delay in the delivery of the samples. We will be working to get the equation development back on schedule during FY2007.

Activity 3: Forage Monitoring Information Delivery and Outreach

Problem Statement and Approach. For an early warning system to be effective, information generated by the system has to be packaged and disseminated to the appropriate user groups in a timely manner. For this activity, an information and communication infrastructure and analysis delivery system will be developed to provide herders with information on current and forecasted forage conditions that will assist them in making timely and specific management decisions in the Gobi Initiative Project region of Mongolia.

Progress. With the production of the forage model and mapping output described in Activity 1, the major components are now available for defining the information delivery and outreach product streams. The Texas A&M and Mongolia Gobi Forage team have been working with the Mercy

Corps information officers in the aimag centers to develop templates for maps and early warning bulletins. The team has also solicited feedback from herders, local forage officers, and national experts on the quality and content of the maps to insure that the information is provided in a suitable format for the Mongolian users, and contains the information in relevant units for the users to understand. This has involved a number of field visits to meet with potential users and stakeholders at the aimag and soum level to collect feedback and suggestions on the format of the maps and information. In addition, the program team has developed keys for the maps and appropriate management responses that could be considered based on the forage conditions. The map keys and responses have been translated into Mongolian, and are currently being reviewed by the Gobi Initiative team, aimag information officers, and other Mongolian rangeland scientists. We are also in the process of developing training manuals for herders, local forage officers, and regional government officials on how to interpret maps and use them in making livestock decisions. The training manual will be completed during the first quarter of FY2007. It is expected that all the information products will be finalized over the winter months, and training of system users will begin prior to the start of the growing season in 2007.

In order to disseminate the Gobi Forage information on current and forecasted rangeland conditions to a large audience, we have been working with the Pact team to develop radio bulletins. These bulletins would report conditions by soum and natural zone (e.g., Gobi desert, steppe, hangai). The bulletins will be broadcast on Mongolian national radio on a bi-weekly basis. The radio bulletin content is currently being reviewed and tested with herder focus groups and other rangeland scientists. It is expected that the first radio bulletins will be broadcast in 2007 at the start of the growing season.

A nation-wide roll-out of the Gobi Forage program is slated for spring of 2007. This will include a nationwide release of the maps and bulletins, broadcast radio bulletins, and the public release of the Gobi Forage website (<http://glews.tamu.edu/mongolia>; currently password protected).

A 15-minute DVD video for introducing Gobi Forage to Mongolian users was completed during this reporting period. This video incorporates three topics covering: 1) the nature of disasters facing Mongolian herders; 2) the Gobi Forage NIRS and early warning technology; and 3) the formation of herder marketing alliances. This video has proved to be extremely valuable for introducing herders, government officials, and NGOs to the nature and products of the Gobi Forage program. The portability of laptop computers equipped with DVDs has allowed our team to show these videos to families of herders in their *ger* (felt tent), and has served as a point of reference for discussing early warning products and herder alliances.

An additional component of the information delivery and outreach activity during this reporting period was training for Mercy Corps personnel and individuals from other natural resource institutions in Mongolia. Training in the use of the PHYGROW forage production model was conducted for 17 Mongolians in May 2006. Trainees were introduced to modeling methodology and parameterization. Field methodologies for gathering model data, as well as model uses for livestock early warning were also presented. A course in ArcGIS was conducted for 15 Mongolians in June 2006. This course provided an overview of the ArcGIS software and allowed trainees to learn to make maps and to be introduced to several spatial analysis techniques. Training in the PHYGROW and ArcGIS software is critical for building human resource capacity in Mongolia for the continued use of Gobi Forage products. During September 2006, an Introduction to Geostatistics and Forage Mapping training was conducted for personnel at Mercy Corps. This capacity will be extremely critical in order for continuity in products as Gobi Forage becomes institutionalized in Mongolia.

Activity 4: Nutritional Monitoring Information Delivery and Outreach

Problem Statement and Approach. Information on livestock nutritional status is a critical component of assessing risk and marketing options for Mongolian herders. The NIRS/NUTBAL system can provide

information on livestock nutritional status, but a critical component of this will be to develop an analysis delivery system that overcomes problems with the remoteness and lack of sample delivery infrastructure (e.g., poor roads, infrequent mail delivery, etc) in Mongolia. In this activity, we will work to develop an analysis delivery system along with information and communication infrastructure to provide herders with information on nutritional status of livestock, and potential interventions to meet production goals. This will entail development of regional NIRS laboratories, along with examining the feasibility of using portable NIRS systems to go directly to herders to collect fecal samples for nutritional analysis.

Progress. One field NIRS laboratory has been established in the Arkhangai aimag. At the site, a forced air oven and a laboratory mill have been placed to allow for the processing of fecal samples. The site will serve as a test location for sample collection, prediction, and reporting methodologies. The site will also serve as a hub for the test routes that will be established for testing the logistics of using a portable NIRS for nutritional analysis, and to demonstrate the technology to herders (Figure 9) and herder alliances. A second field NIRS laboratory with similar function will be established in Omnogobi during FY2007. Information report development for output of NIRS forage quality results is ongoing and has been hampered by the delays in sample shipment described for Activity 2.

Activity 5: Linking the GLCRSP Technology to the Herder Associations

Problem Statement and Approach. This activity will entail linking the GLCRSP technology to the herder associations, which are seen as viable structures, to insure institutionalization of both the forage and nutritional monitoring technology in Mongolia after the end of the Project.

Progress. During this past year, Mercy Corps, via the Gobi Initiative Project, has started the development of a herder alliance in Bayankhongor aimag. This will be a pilot effort, and if successful,

Figure 9. Demonstration of the portable NIRS system for a herder in Mongolia.



other alliances will be established in Gobi Initiative target aimags. Additional work is being conducted in the Tov aimag with leveraged funds obtained from the World Bank Sustainable Livelihoods program. Mercy Corps' approach has been to target herders already working in Gobi Initiative programs, and to work with them to establish a business arrangement for herder alliance membership and transactions. A total of 9 herder cooperatives in Bayankhongor have taken the initial steps to create the Herder Alliance and have started the process to establish a Board of Directors selected from among the herder cooperative members. The Gobi Initiative Aimag based program officers have facilitated the initial meetings and provided guidance on the different organizational structures that the Herder Alliance could adopt. The initial capacity building work is ongoing, and additional interested herder cooperatives are being encouraged to join. A critical component of the alliance formation is the hiring/selection of an alliance manager who will maintain the organization and be the central point of contact with Mercy Corps in continued development of herder alliance services. The Herder Alliance is planned to be formally established during the first quarter of FY2007.

The 15-minute video completed this year for Gobi Forage (described in Activity 3 above) has been extremely useful in explaining the concept of herder alliances and how they would be beneficial to their livestock enterprises. Feedback from one of the herders groups in Bayankhongor has indicated that the video's depiction of how farm and ranch cooperatives work in the US, and how a similar system could work in Mongolia, has motivated them to try to build a successful herder alliance.

A proposal has been developed by Dr. Dennis Sheehy, and it is being sent to various donor organizations to seek additional funds for this activity. Any additional funds will be spent on expansion of the number of herder alliances in each aimag, and strengthening existing ones through enhancement of training materials, alliance staff assistance, and new services.

GENDER ACTIVITIES

The Gobi Forage project in Mongolia is organized to allow a good mix of experienced and young emerging scientists, and is currently comprised of three women and one man. In the Mercy Corps organization, over half of the outreach officers are women who work closely with all members of the participating herder groups. The technology being delivered to the Mongolian herders by Gobi Forage has a uniform accessibility for all gender and age classes. The information disseminated by outreach activities is not "gender filtered," as the families and clan groups of Mongolian herders freely share radios, TV, and written sources of information given the high literacy rate of all age groups and sexes.

Working with Mercy Corps communication and

outreach groups, Gobi Forage will conduct a rapid appraisal of how the information being generated and delivered to the herder groups is used by the families. This will allow us to determine who acts upon the information, and the gender dynamics in consideration of the information in decision making for the well being of the livestock belonging to the family.

For training and workshops, we will continue to provide equal opportunities for both genders. For herder alliance workshops, we will work to insure both men and women decision makers are included.

POLICY

The Gobi Forage project is part of a large initiative of USAID called the Gobi Initiative Phase II, which has key government organizations intertwined in the project. The herder alliances that will be an integral part of the project will provide a direct feedback to the best design of information programs, interventions, and government action resulting from the warnings provided to the communities. Policy makers of each of the critical institutions in the Ministries and the key Universities are involved in the overall planning process of the Gobi Initiative Phase II project, and are part of the information flow process in the Gobi Forage project. Our regional coordinator, Mr. Sean Granville-Ross, works closely with the USAID Mission, the Ministry of Agriculture, and the World Bank Sustainable Livelihoods program that directly advises the government on policy issues in the country insuring a direct conduit into government for policy relevant issues emerging within the project.

OUTREACH

Mercy Corp has an extensive outreach infrastructure as part of the Gobi Initiative with weekly radio shows, quarterly newspapers, and weekly television shows. The model and map outputs from Gobi Forage will be used as content for the radio, newspaper, and television information delivery. During the past fiscal year, Texas A&M scientists have worked with Gobi Initiative personnel

to develop best methods for displaying Gobi Forage output and maps and to develop templates for situation reports and maps. Training manuals are being developed for indoctrinating herders in the use of Gobi Forage information in daily decision making for livestock. The Gobi Forage team has also been working with Pact and Mercy Corps personnel to incorporate GOBI Forage information into weekly news items reported in both the radio shows and newspapers currently used by the Gobi Initiative.

A 15-minute DVD video has been completed, which describes the nature of disasters facing Mongolian herders, the GOBI Forage NIRS and early warning technology, and the formation of herder marketing alliances. The video has been used to introduce herders to the need for technology like that being used by Gobi Forage, how the technology can be used to reduce effects of drought and cold winter (dzud) conditions on livestock, and how herder alliances could be used as a conduit for livestock decision making and marketing.

The Gobi Forage website (<http://glews.tamu.edu/mongolia>) has been developed where results and maps can be viewed along with general information about the project. The site has English and Mongolian versions. Linkages have been developed to allow monitoring site location and results to be downloaded to Google Earth for a GIS representation of the data that requires very little training.

DEVELOPMENTAL IMPACT

Environmental impact. Early marketing and movement decisions resulting from reactions to the livestock early warning system and ultimate organization of marketing alliances will transform grazing pressure on rangelands in the Gobi Region, which, in turn can improve the overall stability and sustainability of these extensive grazinglands. Dissemination of information about forage amounts on a regional basis will provide more knowledge about where animals can be moved during drought or dzud conditions, thus reducing localized overgrazing. This in turn will assist in reducing soil erosion and improving rangeland recovery after drought.

Currently, very little information exists among herders about the actual carrying capacity or

potential diet quality of the land where they graze. There has been an increased tendency for herders to increase the numbers of animals as a hedge against animal losses in the event of future droughts and dzuds. Informed stocking rate and diet quality/animal nutrition decisions by herders could be used to maintain fewer animals of higher body condition going into drought or winter, thus reducing death loss and increasing individual animal productivity while providing for greater ecological sustainability. Knowledge of forage quantity and quality are the foundation for identifying the economic threshold where individual animal versus unit area of land production meet. The information from Gobi Forage, along with training, outreach, and formation of herder alliances will help herders understand that this strategy of over stocking as a hedge against drought or dzud is not sustainable, and can lead to long-term degradation of the system.

Contributions to U.S. agriculture. The technology being applied involves the first use of the CMORPH weather satellite technology for extensive grazinglands. If successful, this technology can be transferred back to the USA to serve the livestock industry by improving the emerging livestock early warning system in the USA. The CMORPH precipitation also has application in USDA Risk Management Agency risk management tools for the ranching industry by providing a spatially explicit means of estimating rainfall for use by biophysical models, which can in turn, be used to assess drought vulnerability and risk. The Portable NIRS technology developed in this project could be used to provide rapid, near real-time monitoring tools for animal nutrition and rangeland health.

Agricultural sustainability. One of the major problems facing livestock production is the flight from extensive grazinglands to urban centers and large interest in peri-urban livestock agriculture. At issue is reduction of herder risk. The Mongolian LEWS system is being designed in such a way that the data is acquired and reported through the existing communication systems with limited continuing costs. TAMU has committed to a near-real time computing capacity to service decision making with fully automated computational systems that have very low maintenance needs. This has proven to be

a very sustainable form of technology delivery, thus allowing the host country to pursue outreach and capacity building. Organized marketing coupled with integration of new risk management tools, should offer a viable mechanism to allow herder groups to raise their livestock in a more sustainable manner and yet protect the fundamental production capacity of the resource.

Contributions to the host country. Since 1999, Mongolia has experienced a series of droughts and severe winters that lowered the national livestock herd by approximately 30%. During this same period, the USAID funded Gobi Initiative Project managed by Mercy Corps has been actively working with herders and herder groups in six aimags. The Gobi Initiative, along with the Gobi Forage project, is working to organize these herders into alliances/cooperatives. These alliances will act as legal entities and will conduct business and financial transactions with the goal of improving enterprise diversification and augment existing enterprises. This will enhance their ability to sell products in a market chain and improve the business climate for herder families.

One of the greatest sources of risk to livestock herders in Mongolia is drought, particularly in the spring and winter ice/snow disasters (dzuds). The technology developed by the Gobi Forage Project in the USAID Global Livestock CRSP, should provide early warning of emerging deficits in forage supplies and/or areas of unsuitable grazing due to climate (snow, ice coverage). This early warning should allow government, at the soum, aimag, and national levels, to focus energies on priority areas and improve decision making on livestock movement and fodder interventions. Simultaneously, the scientists in the Gobi Forage project will be building the capacity within key institutions in Mongolia to allow assessment of animal nutrient balance, and for the first time in remote regions, explore least cost feeding interventions via the use of fecal profiling technology with near infrared reflectance spectroscopy (NIRS) and computer simulation models. When coupled with the herder alliances, these technologies could strengthen the livestock sector and help spawn development of new industries such as processed feeds.

The primary impact indicator will be the

number of people aware of the early warning system and a measure of how they have changed their management practices to improve their financial status. Mercy Corps has collected an excellent baseline survey of all herders participating in the Gobi II initiative, and we will build upon this survey to quantify the impacts or contribution of the Gobi Forage project to the well being of the herders in the study. In the long term, we will use the number of herder alliances formed and length of time they are active as another measure of impact.

The Texas A&M team has trained five Mongolian scientists in the use of the Gobi Forage models and tools. Outreach training in forage modeling and GIS was conducted for Mongolians from the Research Institute of Animal Husbandry, Mercy Corps, Center for Policy Research, and several NGOs in May and June of 2006. PHYGROW forage production model training was conducted for 17 Mongolians, which introduced them to modeling methodology and parameterization. Field methodologies for gathering model data, as well as model uses for livestock early warning were also presented. A course in ArcGIS was conducted for 15 Mongolians that provided an overview of the ArcGIS software and allowed trainees to learn to make maps and to be introduced to several spatial analysis techniques. Training in the PHYGROW and ArcGIS software is critical for building human resource capacity in Mongolia for the continued use of Gobi Forage products.

We have also had discussion with the Director General of the Research Institute of Animal Husbandry for an internship program where undergraduate students from their program would work as summer interns to learn field sampling techniques for the forage sampling activities and to train in the use of NIRS for livestock diet quality analysis. Exploitation of NIRS technology, beyond that described here with fecal samples, will greatly enhance the agricultural research community in Mongolia, due to the non-destructive, non-invasive and cost reduction nature of the method itself.

A drying oven and sample mill is being sent to the High Mountain Research Station in Ihktamir to facilitate cattle and yak feeding and NUTBAL validation trials in that region. These trials will be implemented with both station personnel and

animals, and with cooperation from local herders.

The project components of the Gobi Forage can have a significant positive impact on development of Mongolian agriculture, especially from the perspective of herder and farmer risk management as it affects livelihood. Mongolian agriculture is gradually becoming commercialized as herder and farmer producers realize and respond to the “open market economy” and the incentives and disincentives affecting agriculture production. Transition, which is characterized by a shift from primarily personal consumption based agriculture (with sale of excess product in the market) to a system of agriculture production for urban and peri-urban consumers, is increasing the financial and environmental risk assumed by producers. Full development and institutionalization of components of the Gobi Forage project will provide herder and farmer producers with critical risk-reducing information and, equally important, provide producers with a private sector production framework that allows them to compete effectively in the market economy.

Linkages and networking. The primary linkages in this project is with the Mercy Corps, World Bank Sustainable Livelihoods Program, the USAID Mission, USDA, the Research Institute of Animal Husbandry of the Mongolia Agriculture University, the Mongolia Institute of Meteorology and Hydrology, and the World Bank Global Environmental Facility Lake Hovsgol Project.

Texas A&M and Mercy Corps currently have a MOU with the Research Institute of Animal Husbandry to conduct feeding trials for the NIRS equation development. The Institute through this arrangement also provides housing for a drying oven purchased by Gobi Forage as well as the lab facilities for the portable NIRS development.

Collaboration with international centers and CRSPs. There are no major international center activities in Mongolia.

Meetings were held with personnel from the World Bank Global Environmental Facility Lake Hovsgol Project to discuss areas of collaboration. The Lake Hovsgol project is collecting a large array of vegetation, soil, and climate data as part of their assessment of the effect of climate change on

vegetation and herders in the Lake Hovsgol area of Mongolia. Although this project is outside of the region of study for Gobi Forage, the data being collected by the Lake Hovsgol project can be useful for further validation of the models being used in Gobi Forage. An agreement has been made to share data and to pursue avenues for funding collaboration between the two projects.

OTHER CONTRIBUTIONS

Support for free markets and broad-based economic growth. This project is directly targeted toward reducing risk and forming new marketing structures to help herders move to a free-market, entrepreneurial form of livestock production.

The project links directly to the Gobi Initiative Phase II project that has the overall goal of developing and strengthening new and existing businesses, and works with rural herders to help them diversify and improve their livestock businesses. The project provides a tool for herders to use when making business decisions related to their day to day lives and livestock businesses. In addition, the project also provides the information and tools for other economic development projects working in rural Mongolia, such as the UNDP Sustainable Grassland Project and the World Bank Sustainable Livelihoods Project.

Contributions to and compliance with Mission objectives. The USAID Mission is a critical partner in this project and we are addressing their specific needs for the Gobi II Initiative via coordination with Program Director, Jeff Goodson.

Concern for individuals. The technology being developed, outreach programs, and improved marketing alliances will lead to opportunities for individuals to pursue personal development and accumulation of wealth that is independent of government mandates.

Support for democracy. Although GOBI Forage is not explicitly addressing democracy, the formation of marketing alliances allows a very local form of self-governance to emerge where they can market their goods and services as a unit independent of government.

Humanitarian assistance. Provision of early

warning and affording herders and their families an opportunity to react to life threatening events can be considered a near-real time “humanitarian assistance” program.

LEVERAGED FUNDS AND LINKED PROJECTS

The total value for leveraged funds for the GOBI project during 2006 was \$4,814,412. The sources of those funds were as follows:

Texas Agricultural Experiment Station (TAES), IDC waived, 10/2005-9/2006, \$71,750.

Mercy Corps-Enhanced Nutritional Management for Mongolian Herders. Represents the subcontract from Mercy Corps to TAES for the infusion of the NIRS/NUTBAL Nutritional Management System portion of the Gobi Forage Project that is funded through the Rural Agribusiness Support Program from the United States Department of Agriculture. 1/2006-12/2006, \$115,000.

Department of Homeland Security-503056: Resource Informatics for Defending Against Foreign Animal & Zoonotic Diseases. This project focuses on Informatics, Modeling and Analysis for Foreign Animal and Zoonotic Disease Defense as part of the Department of Homeland Security National Center of Excellence at Texas A&M University. Decision Support Systems and Models are designed to better inform decision making at multiple levels of scale. The Center also provides support to this project through access to computer programming staff, office space, and partial appointments of scientists working on this project. 10/2005-9/2006, \$524,662.

Mercy Corps/ World Bank: Livestock Early Warning for Khulan Habitat. This project focuses on development of early warning technology to assist in predicting the interaction of grazing by herder's livestock with that of the threatened Khulan (Asiatic wild ass). Forage mapping and satellite greenness data is provided to the project for use in a habitat use model. 10/2005-9/2006, \$20,000.

Mercy Corps/ World Bank Sustainable Livelihoods Program: Expansion of the Gobi Forage Livestock Early Warning System to Tov Aimag. This represents a joint project between Mercy Corps and

Texas A&M to extend the forage quantity predictions and mapping of the Gobi Forage Livestock Early Warning System to an additional aimag (Tov). 10/2005-9/2006, \$183,000.

United States Agency for International Development: The Gobi Regional Economic Growth Initiative (Gobi Initiative II). This project is a rural business development program managed by Mercy Corps in partnership with Pact. Gobi Initiative Phase II has a single goal of developing and strengthening rural business, primarily through increasing the number of local enterprises successfully producing greater quantities of goods and services. The two program objectives are: an increase in the number of new and strengthened productive Gobi businesses, and an increase in availability, access to and use of business information by Gobi entrepreneurs. 1/2006-12/2006, \$2,000,000.

United States Department of Agriculture: Rural Agribusiness Support Program (RASP). The purpose of this program is to support agricultural and livestock diversification and growth in up to eleven aimags that are important in economic, environmental, and social dimensions. 1/2006-12/2006, \$1,900,000.

TRAINING

Degree

Zhang, Ann. Chinese, F, Texas A&M University, Rangeland Ecology & Management, PhD.

Non-Degree

Introduction to Phygrow training course, May 23-26, 2006 in Ulaanbaatar, Mongolia. Facilitated by Jay Angerer. To train in the use of the PHYGROW simulation model and the web interface for the model. Attended by 18 participants (8 male and 10 female).

Introduction to ArcGIS training course, June 12-16, 2006 in Ulaanbaatar, Mongolia. Facilitated by Jay Angerer. For hands on training with the ArcGIS software. Topics covered included map making, geoprocessing, editing data, import, export, and related analyses. Attended by 16 participants (7

male and 9 female).

Introduction to Geostatistics and Forage Mapping training course, September 8-15, 2006 in Ulaanbaatar, Mongolia. Facilitated by Jay Angerer. To introduce practical geostatistical techniques of kriging and cokriing. Hands on training using GS+ software for building forage maps. Attended by 3 participants (2 male and 1 female).

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PUBLICATIONS

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of pasture with *Stipa Glareosa* and *Stipa Gobica*.
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ABSTRACTS AND PRESENTATIONS

Angerer J.P., Granville-Ross S., Stewart T.,
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FORAGE: Forage Monitoring Technology to
Improve Risk Management by Herders in the Gobi
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Urgamal M., and Bolor-Erdene L. 2006 GOBI FORAGE: Forage Monitoring Technology to Improve Risk Management by Herders in the Gobi Region of Mongolia. Pasture Management Demonstration activities, "Centre for Policy Reform" NGO, World bank Sustainable Livelihood Project. Erdene soum, Tov aimag.

Bolor-Erdene L., Urgamal M., Tsogoo D., 2006 Forage Monitoring Technology to Improve Risk Management by Herders in the Gobi Region of Mongolia, The second International Workshop on Land Cover/Land Use Study Using Remote Sensing/ GIS 8-10 June 2006, Ulaanbaatar, Mongolia.

Angerer, J.P, Granville-Ross S., Tsolmon N., and Bolor-Erdene L. 2006. The GOBI FORAGE Project - Forage Monitoring Technology to Improve Risk Management by Herders in the Gobi Region of Mongolia. Presentation to the Ministry of Food and Agriculture Livestock and Pasture Coordination Working Group.

Angerer, J.P, Granville-Ross S., Tsolmon N., and Bolor-Erdene L. 2006. Gobi Forage - Forage Monitoring Technology to Improve Risk Management by Herders in the Gobi Region of Mongolia. Presentation to World Bank Sustainable Livelihoods Program.

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**LIVESTOCK TRADE IN
KENYA AND ETHIOPIA (LITEK)**

NARRATIVE SUMMARY

Livestock marketing is critical to development of arid and semi-arid lands in Kenya and Ethiopia. Donors are showing renewed interest in funding livestock marketing activities. Livestock market improvement offers the potential to reduce poverty in areas that are identified as the poorest in these countries. Such activities also allow donors to move from a “relief” mode to a “development” mode in dryland areas, as there is growing frustration with dryland activities being in permanent “relief” mode. The goal of this project was to develop an understanding of livestock marketing in Kenya and Ethiopia specifically, with attention also being paid to cross border implications throughout the region.

Previous project efforts involved holding a priority setting workshop in Nairobi in August 2003. The proceedings of the August 11-13, 2003 workshop held in Nairobi are available at: <http://faculty.maxwell.syr.edu/jomcpeak/marketworkshoppage.htm>. In the fiscal year 04-05, twelve chapters (six funded, six contributed) were reviewed, revised, edited, and formatted by the editors John McPeak and Peter Little. Chapters went through at least two rounds of revisions in response to comments by the editors. An introduction was written by McPeak and Little, and a conclusion by McPeak, Little, and Demment was also included in the volume leading to a total of 14 chapters. The final draft manuscript was sent to the publisher on November 1st, 2005. A first round of proofs arrived back to the chapter authors in late November 2005. The authors made corrections that were sent to the typesetter and a second round of proofs was provided in late December. A variety of formatting and remaining proofing tasks were dealt with in early January 2006. Stephen Sandford was contacted at this time to write a forward, which he

graciously agreed to do in early January. At this time, we also contacted people prominent in the field to write comments / endorsements for the book, and received very nice statements from Chris Delgado, Simeon Ehui, Marcel Fafchamps, Claire Heffernan, Katherine Homewood, Robin Mearns, and Maryam Niamir-Fuller that are included in the final version of the book. Various other small production details continued to be resolved until the book was sent to be published in February 2006. In April, we sorted out all the invoices with IT Publishing. Marketing and publicity materials were provided by IT Publications in June 2006, and were distributed in Kenya and Ethiopia by McPeak and Little who were there for a conference. In July, advance copies of the book went out for review (Carol Kerven notified us that she received a copy and will be conducting a review in *Nomadic Peoples*). On August 28 copies of the books arrived in Syracuse, and in early September, copies of the books were distributed to contributors by mail.

RESEARCH

The material in this section is drawn for the contents of the manuscript.

Pastoral Livestock Marketing in Eastern Africa: Research and Policy Challenges

John G. McPeak and Peter D. Little (editors)
Intermediate Technology Publications,
Warwickshire, UK
ISBN 1-85339-631-1, 288 pages

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- Chapter 3: Livestock Marketing in Marsabit District, Kenya, Over the Past Fifty Years*, by John G. Mcpeak.
- Chapter 4: Determinants of Market Prices of Livestock: The Case of Cattle in Alemaya, Eastern Ethiopia*, by Teresa Adugna.
- Chapter 5: Livestock Market Organization and Price Distributions in Northern Kenya*, by Alan M. Green, Christopher B. Barrett, Winnie K. Luseno, and John G. Mcpeak.
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- Chapter 9: The Geography of Integration: Cross-border Livestock Trade in East Africa*, by Fred Zaal, Morgan Ole Siloma, Rachel Andiema, and Albino Kotomei.
- Chapter 10: Working Across Borders: Methodological and Policy Challenges of Cross-border Livestock Trade in the Horn of Africa*, by Peter D. Little.
- Chapter 11: A Review Of Policies and their Impact on Livestock Trade in Ethiopia during Three Regimes (1965-2005)*, by Yacob Aklilu.
- Chapter 12: Livestock Market Information Systems for East Africa: The Case of GL-CRSP/LINKS*, by Jerry Stuth, Abdi Jama, Robert Kaitho, Jimmy Wu, Abdirahman Ali, Gatarwa Kariuki, and Margaret Kingamkono.

Chapter 13: Pastoralist Coping Strategies and Emergency Livestock Market Intervention, by John Morton.

Chapter 14: Policy Implications and Future Research Directions, by John G. Mcpeak, Peter D. Little, and Montague W. Demment

Biographic and contact information about contributors is listed below in section 12 of this report.

The following description of the contributions is drawn from chapter one of the volume.

The ordering of the chapters follows a conceptual division: we move from the household level, to the market level, to the issues of connections between markets, to national policy implications. The final two contributed chapters place specific emphasis on key interventions that are currently being formulated at the program level that could be scaled up to the national or even international policy level.

Chapters one and two mainly address household/micro-level dimensions of marketing. Chapter 2 by Barrett *et al* is based on data collected by the Pastoral Risk Management (PARIMA) Project of the GL-CRSP in Kenya and Ethiopia from 2000 to 2002. This chapter asks fundamental questions about what constrains households from selling more animals. Analysis of this household level data is used to assess various hypotheses as to what kinds of investments should be made in arid and semi arid lands to improve livestock marketing systems. Critically, they find pastoralists are indeed quite active participants in livestock markets, and argue that many of the hypothesized constraints to pastoral involvement in markets are not supported by the evidence. They suggest that helping pastoralists build and keep herds by supporting viable pastoral production, improvements in institutional and physical infrastructure, and modifications to market institutions offer the most promise for stimulating livestock marketing and improving pastoralists' well being.

McPeak's chapter (3) investigates long term changes in marketing behavior in Marsabit District, Kenya. Given the 'boom and bust' cycles in livestock populations, he argues it is important to develop a long-term understanding of marketing behavior to



reveal what, if any, long term changes are occurring that may be masked by more volatile changes induced by livestock population dynamics. He reports the overall level of sales from the district and the livestock: grain terms of exchange do not appear to exhibit any long term trend. However, household level evidence suggests that sales rates have increased since the late 1960s. The data suggest herders sell more at a given herd size, but this impact has been offset by an overall decline in herd sizes. The findings indicate that: marketing policy needs to be designed both with short term fluctuations in mind and with long term objectives; there is little justification for increasing marketing in order to reduce aggregate herd size in this area; there is little evidence that existing alternative investments are more attractive than livestock keeping; and the goal of increasing revenue per animal sold rather than simply increasing the number of animals sold should be the objective of improving livestock marketing.

Three studies of price formation in livestock markets are contained in the volume. Adugna's chapter (4) is a study of price formation in a cattle market in eastern Ethiopia. He focuses on changes in the price per kilogram liveweight of animals rather than price per head. He presents evidence indicating that animal condition, age, and weight play significant roles in determining price per kilogram. In addition, the reason for purchase and the characteristics of the seller influence price. Finally, he notes that time of day and time of year influence the price that producers obtain for their animals. These findings provide a set of information that can be extended to producers to allow them to improve their production and marketing strategies to increase the benefits they obtain from marketing their animals.

Green *et al* in chapter 5 investigate price formation in four northern Kenyan livestock markets for cattle, goats, and sheep. They find that both the mean price and price variance are influenced by animal characteristics, seller and buyer characteristics, seasonality, and market characteristics. They focus most analysis on the role of market characteristics, as these are most amenable to policy intervention. They present evidence indicating that introducing auctions is an effective way to increase pastoralists'

income, as is improving market competitiveness by reducing transport bottlenecks. They find there is no evidence to suggest that market fees, availability of veterinary inputs or services, or availability of feeds increases market prices.

Radeny *et al* in chapter 6 investigate determinants of cattle prices in seven livestock markets in southern Kenya. They report price formation is influenced by: where the market is in the market chain that brings livestock from producers to consumers in Nairobi; the purpose of purchase; whether or not it is a drought year; and animal specific characteristics. They place particular emphasis on the latter, as they find that there is currently no market incentive to conserve the Maasai Zebu breed, so that *in situ* conservation efforts of this genetic resource may have little impact. They also present information that can be used in developing an extension program to help producers target markets more effectively. Information on how animal characteristics impact price and price differences depending on market type can be used to help producers better define marketing strategies.

Desto *et al* in chapter 7 develop this theme on linking producers to more remunerative markets as a way to increase their revenue. They describe recent efforts to actively link producers to better markets in the rangelands of southern Ethiopia. There has recently emerged a flow of sheep and goats from the rangelands of northern Kenya and southern Ethiopia towards Addis Ababa, where many of these animals are sold onward in export markets (an issue also prominent in chapter 11). A combination of seminars, exchange tours, support for groups, and a credit program were used to support participants in this emerging livestock market chain. This case study illustrates that through coordinated action over time livestock produced in pastoral rangelands can obtain a higher price by accessing particular market niches. They note both the promise and the difficulties of such an approach as revealed by their recent experience in the Borana plateau.

The chapter (8) by Mahmoud also illustrates the process by which pastoralists and traders can be linked to access more lucrative markets, although in this case study traders are transforming themselves into ranchers by leasing land strategically located

near the Mombasa, Kenya market. In this study Somali traders from Garissa District, Kenya are shown to be increasingly concentrating their efforts on the growing Mombasa markets where they have strong cultural and religious (Islam) affiliations with butchers and slaughterhouse owners. To capture more value from this trade, pastoral traders have leased several ranches near the Kenya coast and have begun to fatten immature cattle purchased from the rangelands to sell at the upper end of Mombasa and Nairobi markets. With added success in these enterprises, some lease owners are beginning to turn to full-time ranching and reduce their purchases from pastoral herds in the northeast. Mahmoud speculates in the chapter's conclusion that this trade in high-quality beef may launch the area into the even more demanding, overseas export trade.

Issues of cross border trade implicit in many of the earlier chapters are the explicit focus of Zaal *et al* in chapter 9. They describe how cross border livestock trade operates within a policy vacuum and with mainly informal institutions. They contrast cross border livestock trade between Kenya and Uganda with trade between Kenya and Tanzania and show that the former is strongly shaped and frequently disrupted by widespread violence, often ethnic-based. They find in both areas that trans-border trade appears to be most beneficial for larger traders who have considerable capital for animal purchases and paying high transport costs, as well as control well-developed networks that are needed to be successful in such a risky business. The trade itself only minimally impacts producers and most small-scale merchants are restricted to local, low-priced markets. In the conclusion Zaal *et al* point out the need for improved market coordination by private sector actors and increased public-sector investments in security, transport, and market infrastructure.

Cross-border trade is also a theme highlighted in Chapter 10 by Little. Herders who raise the livestock that enters cross border marketing networks often have little understanding of such market networks. Given official neglect, or even opposition, to such trade, it is often the wealthiest who are able to use their position of power to benefit from the opportunities created by cross border marketing incentives. Drawing on his long-term research along the Kenya and Somalia

borderlands, Little outlines how cross border trade presents particular challenges to both research and policy making. Methodological innovations, such as key actor interviews, opportunistic sampling with an assortment of actors, and participant observation, are required. In the conclusion, Little suggests that the first policy tactic for researchers and practitioners should be educational: to inform policy makers about the activity's scale and importance to local and national economies. Policies that acknowledge and encourage regional trade across borders—rather than discourage it—can strengthen local food security; increase collection of state revenues and investments in key market and transport infrastructure; and reduce price volatility and market imperfections.

Alkilu in chapter 11 provides a broad overview of the interaction between policy and livestock marketing in Ethiopia. In particular, he describes how rapid policy shifts brought about by sudden changes in government have had significant impacts on livestock marketing. He places particular emphasis on how policies have impacted export oriented livestock marketing. In the final section of the chapter, he describes two recent programs that are of particular interest for the focus on cross border trade. In one case, the design of the project does not appear as if it will lead to any significant improvement in livestock marketing. In the second case, there is reason to be hopeful. Aklilu also brings out a theme that underlies many of the other contributions in this volume – it is almost impossible to talk about improving livestock marketing in this area without also improving livestock health care. Policy makers must seriously consider re-engaging with the animal health sector and combining improvements here with efforts to improve livestock marketing.

The final two chapters discuss two issues of critical importance in current policy debates. Chapter 12 by Stuth *et al* describes the development of a livestock information market system in this region. They present the historical record of such systems in the area, noting they have not been particularly successful. They illustrate how recent advances in technology may allow a breakthrough addressing one constraint that has long bedeviled developing such systems – the time taken to gather, transmit, process, and disseminate information

often means the information is of little value by the time it is delivered. They describe an approach to collecting and disseminating information on a broad set of factors that can influence marketing behavior that is designed to improve the connection between livestock producers and markets, improve the well being of participants in livestock markets, and improve market efficiency through improved decision making.

Morton's contribution in Chapter 13 analyzes the recent trend towards using livestock marketing as a crisis period intervention. After carefully considering what is meant by coping with a crisis, he turns to the question of the compatibility of such programs with traditional crisis period coping strategies. He suggests that the key issue is to insure that emergency livestock marketing interventions do not compromise pastoral mobility, the main risk management mechanism (both in drought and non-drought years) practiced by herders. While the evidence is still limited, there are cases from Kenya that Morton argues show that crisis-based marketing interventions increased sales and allowed some herders during a drought to recoup some value through sales. In terms of project design, the chapter suggests that the importance of mobility as a coping strategy implies a need to work closely with local pastoralists and private traders and incorporate their views on appropriate sites for purchasing, rather than with marketing agencies who might prefer to buy animals in market places distant from key seasonal grazing and water points.

Finally, the book's last chapter (14) by McPeak, Little, and Demment, summarizes the policy implications of the studies presented in this volume and identifies critical areas needing further research. It ties together several of the key policy findings of the different chapters. It also describes what we currently know about livestock marketing in eastern Africa and what research questions remain to be answered.

GENDER

The focus of research on market functioning and group formation will identify the role currently played by women participants, and also address the potential for increased involvement of women

in markets. This is most directly addressed by the study of group formation in southern Ethiopia led by Layne Coppock, as many of these groups are women's groups involved in smallstock marketing.

Less directly related to gender but worth noting, three of the research efforts listed above have been led or had significant input made by women (Patti Kristjanson, Winnie Luseno, Sharon Osterloh, Maren Radney) and one also involved women enumerators (Eunice Lepariyo and Sarah Hirbo collected some of the data used in the chapter led by Winnie Luseno). These impacts are worth noting as markets tend to be male dominated, so the presence of female enumerators and researchers in these markets has to some extent challenged existing gender roles, and secondly, since the literature on livestock markets tends to be written by males, this also challenges existing gender roles in the academic world.

POLICY

As noted above, many of the findings are of direct importance to policy makers. We draw on the concluding chapter (14) of the volume to make the following points.

History matters. Government efforts to transform pastoral production into commercially-oriented enterprises and directly intervene in livestock markets have a history in eastern Africa dating back to the colonial period. For at least the past 50 years, policy makers have assumed that pastoral lands are overstocked and degraded and thus contain an abundant 'surplus' of animals that can be tapped through market incentives. The political actors, ideologies, and regimes have changed but the same basic story still persists—pastoralists need to sell more animals! In subtle and not so subtle ways, this volume challenges this old assumption that there is an untapped supply of animals on the rangelands that beg to be marketed. The editors of the volume don't believe the difficulty in increasing the sales volume reflects cultural attitudes toward marketing of animals, but rather the realities of pastoral production in these areas: herds are 60 to 70 per cent

female, herd losses of up to 50 per cent over a period of a few months are disturbingly common, and there is growing evidence that there are thresholds in household herd size below which families are more likely to be driven over time towards total stocklessness than towards recovery. Instead, what the chapters in the book show is that while there may be small, incremental increases in herd off-take rates and aggregate sales volume in response to changing marketing opportunities, greater potential lies with the direction of animals towards markets where they obtain a higher value, as traders and herders respond to new market opportunities. This would allow producers to improve their well being by redirecting animals from local to regional markets, or even to international markets, though the aggregate volume of marketed animals may stay the same or change only marginally. In short, the studies contained in the book indicate it is easier to identify policies and market opportunities that allow producers to 'sell better' rather than 'sell more'.

'Selling better' appears possible given the findings reported in the book. As noted in the chapters by Green *et al*, Radeny *et al*, Zaal *et al*, and Little, herders presently retain 50 per cent or less of the terminal market price. This would suggest that there is room to improve the producer price by increasing market efficiency. What policies are suggested by the studies of the volume to allow producers to 'sell better' and capture more of this share?

New opportunities may also bring about changes in production techniques that could eventually lead to increased volumes, as in the case of the ranches Mahmoud discusses forming in coastal Kenya. As we will note below, there are coordinated policies that can be implemented to change the production environment at a larger scale, thus creating the potential for increased sales volume. But for the most part what the studies in the volume find is that for the immediate future new market opportunities and changing policies create market opportunities that can be seized upon by selling animals at more remunerative prices, as illustrated by Desta *et al* and Zaal *et al*.

Macro policy matters. Macroeconomic policy-making influences the market opportunities that are

available to producers. This is perhaps most clearly brought out in the chapters in the middle section of the volume considering export marketing and cross border trade. The patterns of live animal and meat exports appear very sensitive to decisions made in capital cities, which is most clearly illustrated in the chapter by Aklilu. In this and other related chapters, it is clear that the controls the Ethiopian government placed on meat prices and marketing in the 1980s redirected animals to cross-border markets in neighboring countries. In addition, as Zaal *et al* and Little note, the flows of cross border trade are influenced heavily by the prevailing economic conditions and policies in the bordering countries. The flow of trade across a border can change direction, or even as noted by Desta *et al* flow in one direction for some species while in another direction for another species in reaction to different policies and economic opportunities.

Current policies regarding cross border trade in livestock and livestock products are not clear or consistent. The legal ambiguities increase inefficiency and the potential for markets to be disrupted by rent-seeking behavior. At the regional level, there is a need for the countries of this region to agree on an approach to cross border trade that will reduce the risks faced by participants. This type of agreement is of course easier discussed than implemented given the political realities faced by countries in this region. In addition, as Aklilu stresses, little can be done with cross border marketing without also addressing veterinary policy. As the countries of this region revisit veterinary policy, it would be sensible to harmonize to the greatest extent possible these policies to minimize potential conflict.

Markets are very dynamic. The markets described in the volume are not static. They are changing, adapting, evolving markets. They are shaped by a number of opportunities and constraints which often occur outside the country where the animals are produced. As noted above, there are examples of cross-border livestock flows being quickly redirected; trade and production for high-value urban niche markets being rapidly transformed; and growth in chilled meat exports affecting local market arrangements in southern

Ethiopia that confirm the dynamism of the trade. Policy will need to be adaptive and forward-looking, and research will need to be ongoing. There are emerging opportunities that can be identified by a clever marketing strategy, and we predict there will continue to be opportunities that flexible and timely decision making will be able to exploit. On the other hand, as brought out by Aklilu, opportunities will not always last if not exploited, so that inaction may result in other market participants taking advantage of the opportunity, leaving domestic producers shut out of markets they could have benefited from if policy makers had taken a more facilitative stance.

Improved information delivery is possible.

Given advances in technology, Stuth *et al* describe how it is possible to collect and deliver information on these changing market opportunities to producers at markets in remote areas in ways that were never before possible. The image of the small-scale trader at a distant border market receiving market information from a partner based more than 500km away or reading a text message on a mobile phone delivered from an automated server is likely to become an increasingly common fixture in key markets. The possibility for timely action in response to information about distant market opportunities is created by this flow in information. Since information flow is a component of market functioning, the changes in technology that delivers market information readily to market participants may be an important force in shaping the structure and dynamics of future pastoral markets.

Capacity to act on information is critical and needs support.

Collecting and delivering the information does not always mean people will be able to act on it, however. Capacity building among producers and in production areas will be needed to translate this information into improved well being. As noted by Barrett *et al*, producers are relatively well informed about prices in local markets. And Green *et al* discuss results indicating access to information about prices does not translate into higher producer prices. If producers are not able to access distant markets it is unclear what benefit they will derive from improved information about these markets.

This is where capacity building plays a critical, complementary, role to information delivery. Desta *et al* present one possible model for such efforts, as training and support for alternative income generation activities by creating trading groups allowed these groups to take advantage of new opportunities. Mahmoud, Zaal *et al*, and Little present evidence that in the absence of such efforts, the largest share of the benefits of improved information is likely to accrue to large scale, formal sector traders. However, even this situation may increase the value of livestock marketing overall and still have some benefits for producers as well. More research contrasting the benefits and costs of producer groups forming to market livestock with existing trader networks will help define the kinds of policies that should be adopted.

The livestock market is composed of many different types of markets.

Many of the chapters of the book point out that we are not looking at 'a livestock market' but really many different sub-markets in the livestock sector. Spatially, it is clear that markets in different areas do not operate in the same way, as can be seen by contrasts between Adugna, Green *et al* and Radeny *et al* and within different markets in a given area as stressed by Green *et al* and Radeny *et al*. There appear to be major differences in the price obtained for animals with identical characteristics depending on where the animal is sold. One aspect of this is that locally defined marketing institutions can influence price formation as described by Green *et al*. Specifically, the auction based market delivers higher prices to producers, although it should be noted that Zaal *et al* indicate trader groups frequently seek to undermine efforts to introduce auctions. In addition, local markets differ in how prices are formed. The three studies on price formation in markets allow greater understanding of the relative impact of different animal characteristics on pricing in the specific local setting. With appropriate extension effort, these findings will allow livestock producers to better formulate herd management and marketing strategies, including potentially the formation of marketing groups as discussed above in order to obtain access to distant markets that offer higher

prices. Price information systems may further support such marketing strategies as groups develop greater leverage with traders

It is also evident that within a given physical market location, specific sub markets operate. All three pricing studies find that the characteristics of the buyer and seller impact the price. Whether this is because there are qualitative differences in the animals in these different sub-markets that are not recorded or because there are differences in the nature of the negotiation between the buyer and seller remains as a topic for further research. Evolving market information systems based on animal condition and price, such as LINKS, may provide long-term market data that will allow such analysis. Another aspect of sub-markets existing within a given physical market is noted by Radeny *et al* and Zaal *et al*. Animals sourced from different areas and destined for different segments of the meat market are moving side by side through the overall marketing chain. This offers some opportunities for obtaining access to higher value market chains even in remote areas as the connection to higher value markets already exists for some producers operating in these areas.

The production environment plays a major role in marketing patterns. Barrett *et al* and McPeak stress the fact that household herd size is one of the main determinants of household marketing behavior. Herd size in this production environment is highly variable, due to ‘boom and bust’ dynamics. Given this finding, the argument that increased market volume can be used as a mechanism to regulate herd size appears to be getting it completely backwards. Rather, the evidence suggests changing herd size is one of the main driving forces behind changing market volumes, and if market volumes are to increase, it will require an increase in herd size under current conditions and practices.

This is not to say that offtake rates are immutable. As McPeak notes, over a longer period of time, offtake rates in Marsabit District appear to have almost doubled. However, the fact that herd sizes in the area he studies are by historical standards quite low means that the overall sales volume from the district has shown no overall upward trend over the

past half century. While it may not be the case for all rangelands in the area that herd sizes are relatively low by historical standards, the evidence suggests this is the case for northern Kenya and southern Ethiopia. These low herd sizes have dampened whatever increase in volume would have come about by increased offtake rates and increased market orientation by producers. At the same time, as noted in McPeak’s chapter, increased market integration has allowed herders to meet subsistence needs with these smaller herds that would not be possible to meet by directly consuming livestock and livestock products.

In a related fashion, Barrett *et al* argue that efforts to diversify the economy in pastoral areas is likely to lead to lower, rather than higher, sales volumes over time. As alternative options to generate income develop, reliance on livestock is likely to decline. As they point out, this may have positive implications for welfare of residents of these areas, but does caution that increased sales volumes may be less likely in the long run in more diversified economies. This also is a topic meriting further research.

As we noted above, we believe a major constraint to ‘selling more’ lies in a constellation of factors influencing the production environment. Improved production technologies that reduce risks could positively change the production environment but also present some challenges. As noted by Morton, producers appear to be very interested in veterinary inputs during crisis periods (consistent with the indirect evidence on the interaction between veterinary supplies and price in Green *et al*), but as Aklilu notes veterinary policy is not currently well defined in Ethiopia and our own work in Kenya suggests major improvements could be made there as well. It would seem that better veterinary programs would at least partially address some of the ‘boom and bust’ dynamic in pastoral production in these countries because of the strong interaction between nutritional state, migration strategies during dry periods, and disease infection and response. Changing breed composition to improve marketability is another possible production strategy noted by Zaal *et al* and Radeny *et al*, although the latter study notes how this strategy presents problems for breed conservation. Zaal *et al* suggest different

breeds may be entering different sub-markets, with improved breeds being sold in the highest value added sub-market. Improved feed availability is another production technology available, though Green *et al* report that it does not appear to have a positive impact on prices at local markets. However, Mahmoud presents an interesting response to this situation in coastal Kenya, as traders have taken to developing fattening ranches of their own initiative. Clearly, the availability, feasibility, and drawbacks of alternative improved production technologies in this environment merits further research.

That said, if improved marketing systems and production technologies are to alleviate poverty and improve the general welfare of herders, they must not compromise the main pastoral production and risk management strategy, which is mobility. The discussion by Morton on how markets and mobility can be made compatible in emergency periods contributes to developing policies that allow flexibility in marketing without compromising flexibility in mobility. This issue is also implicit in many of the other studies, where the objective is to develop ways to improve markets without jeopardizing pastoral production systems. Barrett *et al* present a strong argument in their conclusion that mobile pastoralism continues to be the most viable activity possible in the arid and semi-arid areas they study, and McPeak argues that it remains the core economic activity of the area he investigates for the past half century, and no viable alternatives appear poised to challenge it.

OUTREACH

There is no explicit outreach component of this project. We do, however, provide an opportunity for Desta *et al* to articulate their outreach and research effort to a wider audience.

DEVELOPMENTAL IMPACT

Environmental impact and relevance. If we accept that livestock accumulation and low sales rates have an adverse environmental impact, improving market efficiency should reduce pressure

on rangeland resources. As indicated above, there is reason to doubt the logic of this relationship. Instead, the research findings of this project indicate that improved livestock marketing will not automatically take care of environmental problems. Instead, direct, explicitly defined environmental efforts will need to be formulated.

Agricultural sustainability. Livestock marketing is a good example of the type of intervention that is extremely sustainable over time. Livestock marketing exists in the area and has existed for quite some time. Clearly, people are buying animals produced in livestock raising areas, and clearly people in livestock raising areas are selling animals in the market. The question is how do we reduce inefficiencies in this market to improve market functioning and improve the well-being of agricultural producers. There are very few physical inputs required and not all that many capital costs. It is a question of finding out what is working and identifying how to build upon success and eliminate inefficiency.

Contributions to US agriculture. There could be a few ideas on market efficiency or crisis period mitigation that have some relevance to US livestock production areas as we go forward. From a methodological standpoint, the discussion of research methods for cross border livestock trade could have some applicability in the US, as could some of the price decomposition methods used in the market pricing studies.

Contributions to the host country. More than half (18 of 32) of our contributors are citizens of countries in eastern Africa and more than a third (13 of 32) are based in the eastern Africa region. Three chapters are solely authored by African researchers. This type of professional development and exposure allows recognition from outside of the host country of the contribution made by host country researchers. This project has also provided research opportunities that illustrate researchers who remain based in the host country or return to the host country after their studies will not be left out of future research projects conducted by international teams.

Linkages and networking. The contributors to this volume are based in seven different countries at twenty different institutions. We see this type of collaboration as extremely important, and have found

that it leads to strong collaboration over time.

Collaboration with international research centers and other CRSPs. One project was awarded to a team based at the International Livestock Research Institute. In addition, major contributions have been generated from the PARIMA team and the LINKS team. Chris Barrett has also obtained some support for these efforts from his SAGA funds from USAID.

OTHER CONTRIBUTIONS

Support for free markets and broad-based economic growth. This is a project based on improving market functioning by identifying and reducing inefficiencies through targeted research. Livestock raising is the key economic activity in arid and semi-arid areas. Improving livestock marketing offers the only viable potential base for a future of broad-based economic growth in this area. While other activities will undoubtedly be important to the economic future of arid and semi-arid areas, none will be possible without ensuring the health of the core economic activity of livestock raising and marketing.

Contributions to and compliance with Mission objectives. USAID is trying to move interventions in pastoral areas from “relief mode” to “development mode”. They are looking at ways to ensure mission activities contribute to building a viable economic future that prevent humanitarian crises rather than addressing immediate humanitarian needs in ways that do not head off future crises. That is also the aim of this project.

Concern for individuals. Livestock marketing offers a way to build an economic future for areas that contain the poorest of the poor, and are marginalized in the national economy. We are identifying ways to improve the economic opportunities facing the individual livestock producer, and also the prospects for other individuals involved in different parts of the marketing chain.

Support for democracy. There is nothing explicitly in the project that addresses support for democracy, however the alleviation of poverty and the reduction in risk associated with improved markets is certainly an important step to set a

favorable environment for democracy.

Humanitarian assistance. The research focuses on how livestock markets function during crisis periods and also how markets function to help people recover from crisis periods. The goal is to identify how to use market based interventions to minimize the need for humanitarian assistance that takes place outside normal marketing channels. This will both increase the sustainability of future crisis period interventions and reduce their unintended impacts on market functioning.

LEVERAGED FUNDS AND LINKED PROJECTS

Syracuse University, Moynihan Institute for Global Affairs, \$1,500

University of Kentucky, College of Arts and Sciences, \$1,500.

TRAINING

There is no training component of this project. However, students contributed to and authored several chapters.

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**IMPROVING PASTORAL RISK MANAGEMENT
ON EAST AFRICAN RANGELANDS**

NARRATIVE SUMMARY

This was the ninth year of work for the pastoral risk management (e.g., PARIMA) project. The overall goal of our project is the discovery and application of knowledge pertaining to improving risk management—and thus enhancing livelihoods—for pastoral and agro-pastoral people in northern Kenya and southern Ethiopia. Foundation concepts include the exploration of opportunities to better diversify incomes and assets, and how to improve access to natural resources, information, and various public services. The year is best characterized by the following achievements: (1) Twenty-five publications were produced, including two dissertations, one thesis, 10 peer-reviewed papers and book chapters, and 11 GL-CRSP Research Briefs; (2) twenty professional presentations were given at venues in East Africa, the USA, and Europe; (3) three students received graduate degrees with partial support from the GL-CRSP, with another 14 students in the pipeline at universities in the USA, Kenya, and Ethiopia; (4) five meetings were sponsored or co-sponsored by PARIMA in Kenya and Ethiopia that focused on non-degree training for research staff of national organizations with 218 attendees overall; (5) another seven events were held in southern Ethiopia that focused on non-degree training for pastoralists—also sponsored or co-sponsored by PARIMA under the auspices of the USAID Mission to Ethiopia—with 1,991 attendees; (6) an annual survey of 330 pastoral households was successfully concluded in southern Ethiopia and northern Kenya, a continuation of work started in 2000 that will provide an unparalleled time series of data concerning dynamics for pastoral risk management; and (7) progress continues to be made in establishing working relationships among

PARIMA scientists, policy makers, and donors in East Africa and the USA. We have remained true to our original problem model. Work plans and outputs in Year 9 are on track with what we outlined in the original project proposal. Team members have been very productive and creative with resources provided by the GL-CRSP.

RESEARCH

Activity 1: Research on Risk at the Individual, Household, and Community Level

Problem Statement and Approach. One of the core issues investigated by the PARIMA project is the extent to which pastoralists share a common perception and experience of risk. One assumption is that most risk experiences are common to most pastoralists. This assumption has important implications for the way that interventions are structured. When risk is broadly shared across a population, external resources are essential to enable recovery from shocks, and rural financial, marketing, and social insurance systems are prone to failure. When the risk experience is highly variable (idiosyncratic) within a population, local systems have greater capacity to manage risk internally, so long as a basic physical and institutional infrastructure is in place. Therefore, one of the first research activities of PARIMA has been to explore intra-regional variability in risk exposure and risk perceptions. Two different research efforts have contributed to this activity. We started with a participatory risk-mapping activity documented in GL-CRSP Annual Reports for 1999 and 2000. This was followed by a

more detailed, repeated survey implemented for 330 households in 11 communities (six in Kenya and five in Ethiopia) using a cluster sampling approach. Five of these communities are Boran, with one each from the Rendille, Ariaal, Il Chamus, Gabra, Samburu, and Guji. The survey was launched during March 2000, and was successfully repeated on a quarterly basis over the next two years, ending in June 2002. Survey work has been devoted to: (1) delineating sources of risk affecting individuals, households, and communities; (2) understanding the effectiveness of various indigenous tactics for reducing risk exposure such as livestock accumulation, livestock mobility, and social insurance systems; and (3) understanding the effectiveness of various introduced tactics for reducing risk exposure such as livestock marketing, access to rural financial networks, economic diversification, and use of relief as well as other forms of external assistance. Communities have been stratified and purposively chosen so as to capture important differences in agro-ecology, access to towns and infrastructure, and ethnicity. Individual-level surveys have not only been fielded to household heads, but also to a randomly selected junior male and female adults from each household in order to illuminate gender and generation differences that condition risk exposure and response. The survey instruments capture information on household structure, asset holdings, activities, consumption, mobility, livestock transactions, experience with raiding, risk assessments, past risk exposure, etc. Effort has been made to capture actual behaviors as well as risk perceptions. Updated descriptions of survey findings have been documented in GL-CRSP Annual Reports for 2001, 2002, 2003, 2004, and 2005.

Progress. In 2003 we embarked on an annual survey (reduced frequency) of the same 330 households with an additional goal of capturing dynamics related to the drought recovery cycle. Work on this activity has been dominated by data processing and writing in 2004-05. Co-leaders for this activity include Drs. Chris Barrett, John McPeak, and Cheryl Doss. Writing and synthesis have largely occurred in the USA. Field data collection has been ongoing in northern Kenya and southern Ethiopia.

Critical supervision of survey data collection has been provided by Dr. Getachew Gebru (Ethiopia) and Mr. Rueben Lemeunyete (Kenya). Outputs from this activity remain on target.

This activity has contributed to nine publications in the past year, including three Research Briefs and one doctoral dissertation. See Publications and Training for details. There have also been two presentations related to Activity 1 (see Abstracts and Presentations). In this report we add some detail and new insights pertaining to this activity, with a focus on studies conducted by Drs. John McPeak, Cheryl Doss, and Chris Barrett.

Do Husbands and Wives View Milk Markets Differently? Efforts to develop market opportunities are a key element of the current USAID agricultural strategy. In this study, we illustrate how milk marketing in two pastoral towns in northern Kenya is influenced by patterns in intra-household decision making. Men make migration decisions and women market milk. Since milk markets are in town and households change location frequently, the husband's decision about where to settle the household has obvious implications for the distance his wife will have to walk to the milk market in town.

The Gabra are nomadic pastoralists that reside in the Kenya-Ethiopian borderland. They raise mixed herds of camels, cattle, goats, and sheep in an arid environment. They obtain most of their calories from milk from their animals, but they are increasingly meeting some of their caloric requirements by consuming grains purchased from the proceeds of livestock and milk sales.

Gabra culture distinguishes clear rights, roles and responsibilities for men and women. The symbolic distinction is between that which is outside of the household dwelling, which is the men's domain, and that which is inside the dwelling, which is women's domain. Each evening, men milk the animals after they return from grazing. The husband is handed the containers full of milk as he sits outside the door of the hut. He inspects the milk, takes a sip, and then passes it through the door to the wife. Once it enters the hut, management of the milk becomes the responsibility of the wife. Traditionally, this meant that women are responsible for the decisions about how much milk will be consumed fresh, how much

will be conserved as ghee or fermented milk, and how much will be shared with other households. Over the past forty years or so, as small towns have grown in the Gabra area, women now have the opportunity to walk to the nearest town and sell the milk in exchange for cash.

The development of milk markets in this area is an example of the changes that are occurring throughout Africa. Milk is a traditional product, produced and consumed within a clear set of cultural rules. The creation of markets challenges these social norms and provides new opportunities. These norms surrounding milk are being renegotiated, both implicitly and explicitly, as households weigh the costs and benefits of these new opportunities.

Development policies usually assume that households will respond cooperatively to new market opportunities. However, if this is not the case, then realized outcomes may be much less promising than the anticipated ones. Efforts to use improved access to markets as a development strategy may need to be designed with explicit mechanisms to reduce the potential for intra-household contestation.

The data analyzed are from a survey of 88 households in the areas around Dukana and North Horr in northern Kenya. Data are available for each of the four seasons (rainfall is bimodal in this area, with the two rainy seasons separated by dry seasons) for the years 1993-1997.

If total income is defined to include the cash value of all goods produced and consumed within the household together with cash income, milk sales account for a relatively minor portion of total household income. In Chalbi, milk sales account for 3% of total income and in Dukana the corresponding figure is 1%. But milk sales are a much larger portion of cash income: Milk sales account for 11% of cash income in Chalbi and 14% in Dukana. The majority of households, 67% in Chalbi and 86% in Dukana, sold milk in one or more of seasons analyzed.

Milk prices of 20 Kenyan shillings per liter were constant over the four years studied (around \$0.30). Maize prices averaged 20 shillings per kilogram. Thus, the exchange rate is one liter milk to one kilogram of maize. However, when expressed in caloric terms (1 liter of milk valued at 750 calories, 1 kilogram of maize valued at 3650 calories), we find

what has been called the “caloric terms of trade.” In this area, the sale of one liter of milk generates almost five times as many calories from the maize that can be purchased with the proceeds than would have been generated by direct consumption of the milk.

On average, it took five hours to walk to the nearest town from the household in Chalbi and eight hours in Dukana. Milk production per day from the household herd averaged 4.5 liters per day in Chalbi and 3.5 liters per day in Dukana. The trips taken by wives to towns typically involve waking up pre-dawn, carrying some share of the milk collected the prior evening from the household herd in a small plastic or traditional woven container, and walking to town where they sell the milk themselves. They then use the income generated by these milk sales to make purchases before returning on foot to the household before night falls.

In our theoretical analysis, we developed the implication that if households behave according to a “cooperative model,” husbands and wives would jointly decide where to locate the household in order to reap the benefits from milk sales, while taking other factors into consideration. If households act according to what we call the “traditional model,” based on what people described as a possible outcome in our fieldwork, husbands make the location decision without considering its impact on milk sales. The men make the decisions based only on the needs of the herd. Finally, following what we describe as the “contested model”, husbands view wives marketing milk with trepidation, and use migration decisions to limit their wives’ milk marketing activity. We identified the sign of a specific coefficient in our empirical model that could discern between these three models.

The statistical analysis allowed us to investigate patterns in decision-making. In particular, it allowed us to identify how the relationship between the decisions of where to locate the household and how much milk to sell. To conduct this analysis, we also used information on the household such as the age of the husband, the age of the wife, household size, herd size, and presence of pack animals. Information was also collected on time period characteristics, such as rainfall levels, what season it was, whether food aid was being delivered, and whether there were any

livestock raids in that period.

Our findings were consistent with this third model, suggesting that household decisions about migration and milk marketing were best viewed as contested. Why might husbands and wives contest decisions about milk marketing? A variety of explanations were proposed when we returned to the field with our findings. A leading explanation was that husbands are not comfortable with their wives gaining control over income. While some husbands claimed that milk sales were a good opportunity to generate cash to buy food for the household so that they did not have to sell livestock, we frequently encountered husbands who were concerned about what their wives did with money from milk sales. Another explanation that was given was that men did not like the fact that sales reduced milk available for consumption by the household, as milk is the main component of the diet as noted above. A third interpretation advanced was that husbands were uncomfortable with their wives being alone in town, largely centering on the concern that they might develop relationships with other men. Our data did not allow us to distinguish among these different explanations which we leave as a topic for further research.

Improving market opportunities is an important part of development policy. As noted above, markets—through forces such as the caloric terms of trade described above—can play a crucial role in food security. It is natural that efforts to improve the well being of people in pastoral areas should identify markets as a key intervention.

In addition, the status of pastoral women merits special concern. Women's traditional roles are very circumscribed. Milk marketing is one of few activities that is both consistent with women's traditional roles and provides opportunities for income generation.

However, this study indicates that one can not directly proceed to the conclusion that improved milk marketing opportunities will automatically improve women's, or pastoral households,' well-being. One practical implication of this study is that it illustrates how intra household contestation can provide an example of why a promising development intervention has less impact than expected, and cites

examples where these intra-household dynamics even led to project failure. From a design standpoint, it illustrates how critical it is to understand the gender dynamics inside households to design programs that reduce the potential for intra-household contestation. With further research, the underlying reasons for resistance to milk marketing by some husbands could be clarified. Armed with this information, a development project aimed at improving milk marketing could also facilitate dialog about these concerns with men and women within the community. Such a dialog could simply "clear the air" and bring out into the open for discussion issues that may not have been recognized, or could serve as a foundation for developing institutional responses that design mechanisms to address these concerns.

Development Priorities in the PARIMA Study Area: Results of a Ranking Exercise. This study investigates development priorities of individuals in arid and semi-arid areas of northern Kenya and southern Ethiopia that are predominantly used for pastoral production. Using a ranking exercise, individuals were asked which development interventions had been the most helpful in the past and to indicate their priorities for future development interventions.

Development efforts have meet with limited success in pastoral areas of Africa. Recently, donors have begun showing renewed interest in pastoral development. They express frustration that development efforts in pastoral areas have been reduced to periodic humanitarian relief interventions that offer little prospect of long term improvements to peoples' lives. As donors begin to formulate plans that address long-term development needs, there is a need to prioritize among different types of interventions.

In response, the PARIMA team in 2001-2002 fielded a survey that elicited development rankings from individuals in 11 communities in northern Kenya and southern Ethiopia. A total of 396 individuals (249 in Kenya, 147 in Ethiopia) were asked to rank the effectiveness of past development interventions and rank the development interventions they felt would be most helpful in their community in the future. Here we summarize the findings of

Table 1. Experience of respondents with development interventions.

TYPE OF PROJECT	% OF INTERVIEWEES IMPACTED
Food Aid	97%
Human Health	88%
Livestock Health	76%
Water	74%
Education and Literacy	62%
Conflict Resolution and Security	62%
Transport Improvement	56%
Livestock Marketing	36%
Natural Resource Management	31%
Cultivation	28%
Wildlife Management	26%
Other Services (phone, electric)	18%
Restocking	13%
Savings and Credit	4%
Alternative Income	2%
Institutional Development	1%

this study.

We first asked about the personal experiences of respondents with different kinds of projects. Table 1 summarizes the responses of whether they had individually experienced these interventions. Almost everyone in this area had received food aid. Most people had experienced several interventions, with human health the next most common type of intervention (after food aid), that had affected

respondents, with livestock health and water not far behind.

We then asked them to rank the development interventions that they felt had been most helpful to them and to the community. The responses to this question were converted to a value between zero and one, with zero meaning that the project was not helpful at all and one being a project that was the most helpful (Figure 1). There was little difference between their rankings of the helpfulness to themselves versus to the community, so we focus here on the results for the helpfulness to the community. Human health and water projects were by far the most helpful interventions in the collective view of our respondents, with livestock health and food aid also highly rated. Thus, the interventions most commonly experienced were also rated the most helpful, generally.

We also asked them to conduct the same kind of exercise for ranking the development interventions they felt would be most helpful in the future. Again, we found little significant difference between rankings for the individual and for the community, so we report the results for priorities for the community (Figure 2).

In Table 2 we contrast the ordering of the intervention categories presented in the previous illustrations. Overall, the results illustrate that development efforts targeting human health, water, and education are seen as the most important, both in terms of past projects and people's priorities for the future. Interventions targeting the pastoral production system such as livestock health, livestock marketing, and herd restocking fill in the middle range of the rankings. A variety of other types of interventions fall into the lower range of the rankings.

The results for food aid merit particular attention, as the motivation for increasing development efforts are often expressed as arising due to frustration with the recurring need for food aid. Food aid, as noted above, is the most widespread development intervention. Respondents overall find it has been helpful; it was ranked the fourth most

Figure 1. Ranking of Past Interventions, Most Helpful to the Community.

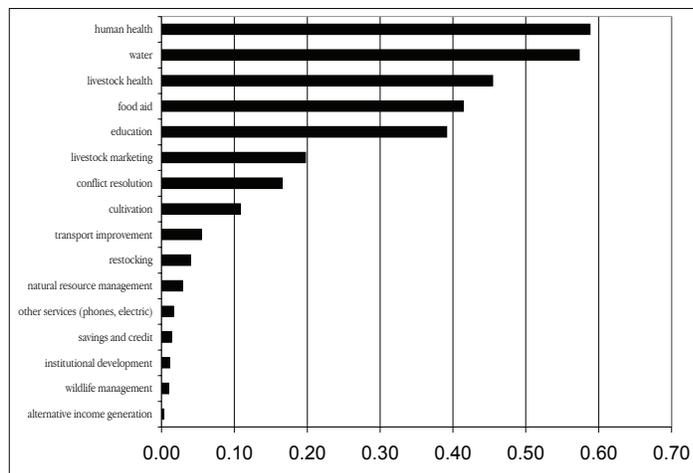
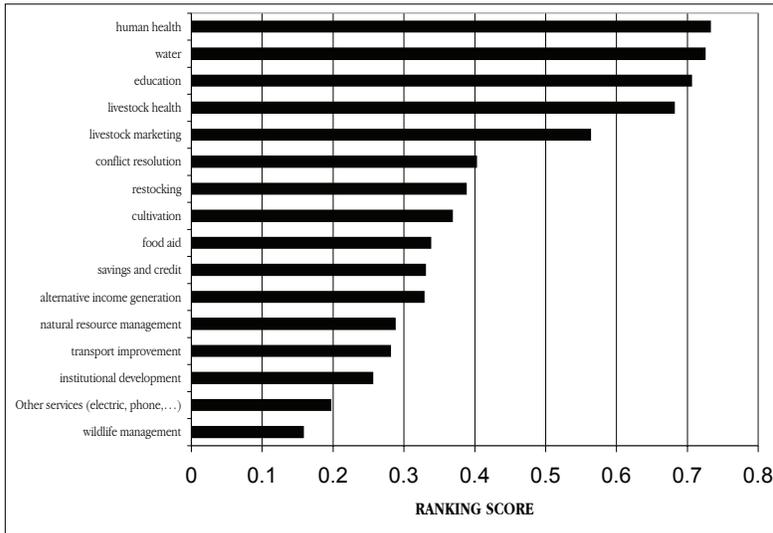


Figure 2. Ranking of Interventions, Most Helpful in the Future.



helpful type of intervention in the past. However, looking to the future, it slips to the ninth priority. In discussing these results with the communities, the general explanation of this was that if other development interventions succeed, there will be less need for food aid in the future. Thus a reduction in importance of food aid in the future is not just a desire of the donor community, but also a desire of the residents of these areas. But in the absence of effective means of supporting fragile livelihoods, our respondents plainly believe food aid has been valuable.

The key conclusion of this study is that development efforts supporting basic human needs such as human health, clean water, and access to education are most highly desired by residents of this area. Development efforts should focus on ensuring that the basic human needs of residents of pastoral areas are met. This means that focusing on the development needs of “pastoral peoples” should emphasize the “people” first and the “pastoral” second. Past emphasis on the livestock on which many pastoral peoples’ livelihoods depend is viewed

as being only moderately helpful in the past rankings and, in the expressed view of these peoples on future development priorities, is less desirable than an emphasis on basic human needs.

Inter-personal, Inter-temporal, and Spatial Variation in Risk Perceptions. Residents of the arid and semi-arid lands (ASAL) of east Africa are exposed to a myriad of risks. Some originate from the nature of the pastoral production system that is the main economic activity in these areas. The ASAL have rainfall patterns that are highly variable temporally

and spatially, making pasture and water availability for livestock unpredictable. These risks translate into risks of food shortages. Other risks originate from government policy; for example, quarantines can halt the livestock sales that are many pastoralists’ primary source of cash. The lack of government presence can also lead to risk exposure; for example, weak state

Table 2: Summary Comparison of Results

Type of Project	PAST EXPERIENCE	PAST RANK	FUTURE RANK
Human health	2	1	1
Water	4	2	2
Education	5	5	3
Livestock health	3	3	4
Livestock marketing	8	6	5
Conflict resolution and security	6	7	6
Restocking	13	10	7
Cultivation	10	8	8
Food aid	1	4	9
Savings and credit	14	13	10
Alternative income generation	15	16	11
Natural resource management	9	11	12
Transport improvement	7	9	13
Institutional development	16	14	14
Other services (electric, phone)	12	12	15
Wildlife management	11	15	16

security services contribute to physical insecurity in these areas. Finally, the relatively poor infrastructure in these areas makes *ex ante* forecasting of these risks problematic and makes *ex post* coping with risks difficult, as roads, health centers, veterinary services and markets are poorly maintained or non-existent.

This study investigates how ASAL residents perceive risks facing their households. It examines which risks people are concerned about and the degree to which risk perceptions vary across time, communities, households within a community, and among individuals within a household. Appropriate policy responses clearly depend on how risks vary across time, space, and among and within households. Expressed risk perceptions are based not only on the objective risks that individuals face—such as the probability of low rainfall—but also on their subjective assessment of exposure to different shocks and their capacity to manage those shocks, *ex ante* or *ex post*.

From March 2000 through June 2002, the PARIMA project collected quarterly survey data from 300 households in 11 communities within a single, contiguous livestock production and marketing region in northern Kenya and southern Ethiopia. The specific sites were chosen to capture relative variation in agricultural potential, market access, livestock mobility and ethnic diversity.

Rainfall is low and variable and the study period coincides with a major drought that affected much of the area in 2000 and continued well into 2001 in some sites. The infrastructure, in terms of roads, schools, and health facilities, is extremely weak throughout the region. In each site, a baseline survey was conducted in March 2000. Repeat surveys were conducted quarterly for an additional nine periods, through June 2002.

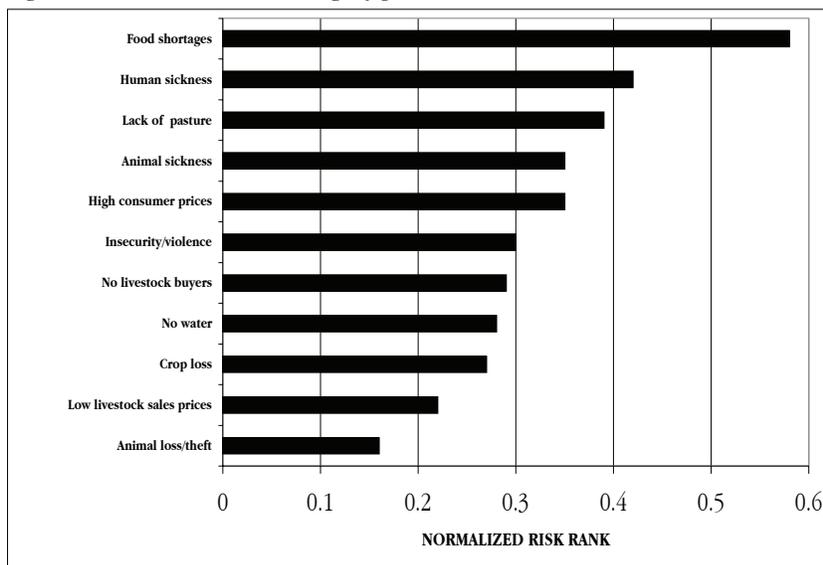
In each household, we interviewed the household head and, if applicable, one randomly selected spouse and one randomly selected non-head/non-spouse adult (age 18 years or older) in the household. The household head answered questions regarding the income, assets, and activities of the entire household. The other individuals surveyed reported on their own assets, incomes and activities. In addition to these standard household survey questions about income, consumption, activities and livestock herds, we asked respondents to identify and rank their concerns from a list of twelve different types of risks that could adversely affect their household in the coming three months. These data permit us to relate forward-looking subjective assessments of risk with households' and individuals' current states.

Figure 3 presents the overall results of the risk ranking, where a higher number means a risk was ranked as more of a concern. The risks ranked as the greatest concerns were shortages of food, human

sickness, lack of pasture, animal sickness, and high consumer prices. Multivariate econometric analysis allows us to analyze how risk rankings of these concerns are influenced by individual, household, and community characteristics as well as changes over time and space. We only summarize the findings here.

At the community level, we control for the mean percentage change in household herd size within the respondent's community over the previous survey period, for the occurrence of any livestock

Figure 3. Normalized risk rankings by pastoralists.

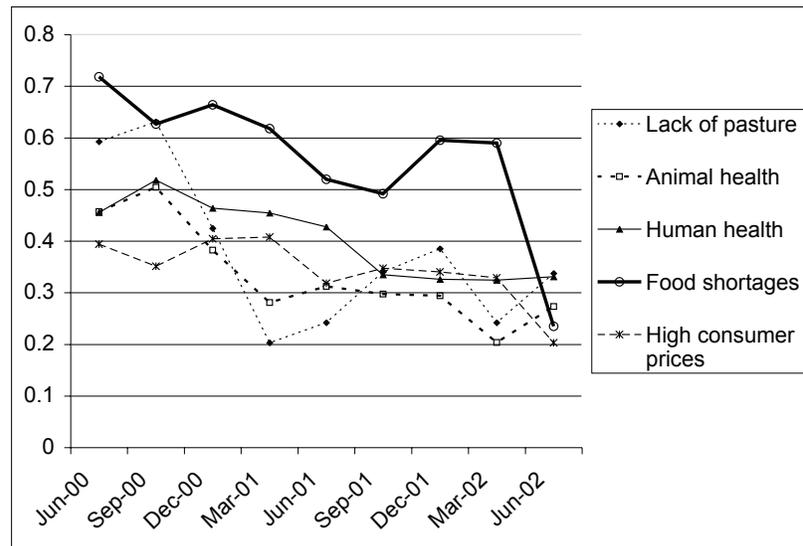


raids, animal quarantines, or outbreaks of animal or human diseases in the community during the previous quarter, for the deviation of monthly consumer prices from their mean over all months in that location, for the number of livestock traders buying animals in the community in the previous three months, and for a subjective indicator variable reflecting the ease of selling livestock. This is an unusually rich set of community-level covariates, especially in tracking the evolution over time in such variables, and thereby offers a rare glimpse into the impact of community-level variables on individual-level risk assessments.

Each of the community-level shock variables was statistically significant in explaining the ranking of at least one of the concerns. Wald tests found the community level shocks were jointly statistically significant for each of the eleven risks studied. Individual-level risk assessments respond significantly to broader, community-level shocks, indicating information flow and social learning with respect to risk.

Once we control for community-level variables, household-level characteristics and shocks have surprisingly modest effects on risk rankings. There are only two household characteristics, asset value and income, that had a statistically significant impact on more than one of the top five concerns. Household size and herd size impact one ranking each. Jointly, household level characteristics were statistically significantly associated with individual-level risk rankings for only 6 of the 11 risks enumerated, in striking contrast to the community-level characteristics that were uniformly highly statistically significant. Even more surprisingly, household-level shocks had little effect on individuals' risk rankings. Illness is the only household shock variable statistically significantly associated with risk rankings, and only for one of the risks. Surprisingly, the indicator of a recent death in

Figure 4. Risk rankings over time for the top five concerns.



the family is not significant for any of the rankings. Joint Wald tests indicate that household-level shocks were not statistically significant in explaining individual rankings with respect to any of the 11 risks we study. Once one controls for household and community characteristics and community-level shocks, households' idiosyncratic risk experiences seem to have negligible effect on individuals' risk perceptions.

Finally, we consider the impact of individual characteristics. The only statistically significant variable in more than one ranking is whether or not the individual is a head of household. Gender proves statistically significant for only one of these five risks. Age, education, and status as a wife do not significantly influence the rankings of any of the top five concerns. Wald test results illustrate that individual characteristics had a relatively modest impact on individual risk rankings, being jointly statistically significant for only 6 of 11 risks. Four important implications can be drawn from this analysis.

First, because risk perceptions vary markedly across time, common development practices such as Rapid Rural Appraisal, in which researchers drop into a village for a brief visit to ask about needs and concerns, may give results that are only relevant for that particular moment. Within just a 27-month period, we observed both sharp

seasonality and striking inter-annual changes in risk rankings that call into question the generalizability of static, snapshot assessments of risk in dynamic communities (see Figure 4). The risk rankings change markedly over time. Local events, such as cattle raids, drought, and the imposition of quarantine for animal disease control, have an important impact on the risk perceptions. Since rapid assessments are frequently fielded in response to such events, they may be especially prone to distortion. These results imply a need for ongoing, longitudinal monitoring of locations thought vulnerable to multiple risks in order that external interventions can adapt appropriately to changing risk profiles in dynamic settings such as in the pastoralist areas of east Africa.

Second, variation in risk rankings is more pronounced between communities rather than within them. Although there can be difference across households as stratified by herd wealth or across individuals based on gender, these differences are much smaller than those we see in response to the spatial and inter-temporal changes. This implies that community-specific planning to mitigate and cope with risk is needed. A single plan for a broad region runs the risk of overlooking community specific concerns. Since most of this variation is between rather than within communities, community-based monitoring and formulation of development plans may suffice. While a community plan that does not take into account the heterogeneity of concerns across and within households runs the risk of being biased towards a subset of community members, our results indicate that it is more important to push for finer grained analysis between different communities rather than within them.

Third, community-level shocks associated with rainfall, violence, animal and human disease, market conditions, etc. have a pronounced effect on individual-level risk perceptions, while household-level shocks associated with human illness and mortality, or herd losses do not. This suggests that people learn actively from the experiences of others around them and adjust their risk assessments quickly in response, corroborating prior work in the area on subjective expectations of rainfall. Although covariate shocks are relatively weakly correlated with individual-level income and asset shocks in this area,

individuals appear to adapt their risk assessments more in response to community-level shocks than to those that strike their own household. This would also be consistent with the argument that social networks or sharing mechanisms within communities lead individuals to be less concerned about household specific shocks compared to community covariate shocks, though investigating this interpretation is left as a topic for further research.

Fourth and finally, the most prevalent fear was of food insecurity. The fear of food insecurity is largely driven by the fact that the study area regularly suffers drought, herd loss, and sudden decreases in food (especially milk) availability. The perception of risk is highest for the core outcome of not having enough food, rather than underlying causes such as insufficient pasture, crop failure, high consumer prices, or livestock mortality. Policy responses to food insecurity in the area continue to focus heavily on emergency assistance in the form of food aid, the implementation of which is often not timely or well targeted. More stress also needs to be given to designing humanitarian assistance that is compatible with pastoralists' preferred drought mitigation strategy: migration. Food aid is all too-often distributed from towns, which discourages mobility to remote rangelands. In addition, human sickness is a major concern throughout the study area. Health services are minimal and improving them would help address this risk. Another finding is that lack of pasture is a much greater concern than lack of water, suggesting that pasture rather than water is viewed as the more binding constraint on pastoral production in this area. As the insecurity in this area is often characterized as a result of "cattle rustling," it is worth noting that the results indicate the fear of losing animals in a raid is relatively minor compared to the fear of insecurity. Individuals in this area are viewing insecurity as multi-dimensional, suggesting policy responses must go beyond anti-stock theft efforts.

Activity 2: Thematic Investigations Dealing with Conflict, Natural Resource Management, and Livestock Marketing

Problem Statement and Approach. The broad objective of this activity has been to investigate how support systems such as livestock marketing, rural finance, natural resource tenure, indigenous social networks, and provision of climate forecast information affect pastoral risk management in our study region. This work is packaged as ancillary studies to the major survey described under Activity 1. Work was conducted by African and American graduate students matriculated at US universities, African collaborators with local non-governmental and governmental institutions, and recent degree-holders previously educated with PARIMA support. Studies of natural resource tenure and issues pertaining to cross-border livestock marketing dominated our work in the past year. This research has involved several social science approaches including household surveys, community focus groups, and key informant interviews.

Progress. Co-leaders of this activity include Drs. Peter Little and Chris Barrett, with major contributions made by graduate students. This activity has led to eight publications in the past year. These include two Research Briefs, one master's thesis, and one dissertation. See details in Publications. There were also six presentations (see Abstracts and Presentations). Some research highlights provide by Drs. Peter Little, Andrew Mude, Chris Barrett, and colleagues are as follows.

Informal Institutions and Cross-border Livestock Trade. Trans-border trade in livestock in sub-Saharan Africa plays critical roles in meeting regional food security needs and generating income for thousands of herders and traders. This work addresses the institutional aspects of cross-border livestock trade in the Greater Horn of Africa, especially in the Kenya/Ethiopia/Somalia borderlands. As a preview, while informal exports and imports of animals are illegal in Kenya and Ethiopia, local institutions and agreements often allow the trade to function "on the ground" in the absence of official recognition. For policy makers, what is

particularly challenging is that cross-border trade thrives in the absence of government interventions and policies, while punitive controls against it usually re-direct the trade along unofficial channels.

Trans-border trade in the Greater Horn of Africa represents a particularly important and challenging activity for policy makers. On the one hand, it epitomizes the essence of informal or "shadow" trade, operating along remote borders in a vast region where government presence is particularly weak, as well as generates large amounts of revenue. Illustrative of this reality, is the fact that official annual exports of cattle from Ethiopia, the most populous country in the region, often are less than 2,000, when in fact more than 25 times this amount are unofficially exported across borders. On the other hand, most governments in the region rely on official exports of primary commodities to earn foreign exchange, and thus, view informal cross-border trade as lost public revenue. Unfortunately, politically charged arguments for controlling borders dictate that trade in agricultural and other benign products usually are neglected or constrained by government policy. For the livestock herders or pastoralists who dominate the area's border regions, market alternatives to unofficial cross-border trade are minimal. The informal nature of trans-border trade determines that traders rely on a range of local institutions and practices to facilitate their businesses. Most of the important innovations are centered on finance, broker services, and transport.

Financial institutions (hawala). Trans-border livestock trade relies on a range of different informal finance institutions in support of their businesses. When credit is used in cross-border commerce, more than 95 percent of it is obtained informally from kinsmen, friends, and associates. Very few livestock traders (less than 10 percent of the total) have access to formal sources of finance. In the case of the Somalia border areas, informal finance services minimize risks associated with carrying large amounts of cash in an unstable environment. Somali border traders can take their earnings to Nairobi, convert them to dollars, and then 'wire' them back to money houses in Somalia, where they can be picked up by associates. This informal practice, called the *hawala* or *hawilaad* system (meaning "transfer" in Arabic), avoids the need

to carry large amounts of cash across the border. In other cases the livestock trader will convert part of his earnings in Kenya into tradable goods, which he will arrange with a wholesaler to be picked up at the border to avoid the risk of traveling in northeastern Kenya with excess money. These transfer services are mediated through informal money houses and middlemen, who assume special importance in most forms of long-distance trade, including livestock. While much of the cross-border livestock trade is calculated in local currencies, final payments often are made in US dollars and the actual handling of cash in large transactions is minimal.

Many of the important informal finance businesses that livestock traders use in the region are based in Nairobi. The enterprises usually charge fees of 3-6 percent to 'wire' funds from Kenya to locations in Somalia; formal banks usually charge 10-12 percent or more for the same service. Different forms of wire transfer and credit minimize risk and reduce the physical handling of worn Somali notes, which slows their deterioration and helps to keep them in circulation. The system sometimes functions in the idiom of the clan system, where knowledge of sub-clan and family relations are used as cross-checks on identity.

Market Brokers (Dilaal): Since official price information is poor in the border areas, traders rely on informal means of obtaining market information. This complicates the search for markets by individual traders and herders, who often rely on local brokers (*dilaal*) for assistance. The broker's role is to match the buyer with a seller, the latter often has traveled 100 km or more to market, and to insure the legitimacy of the sale (including the assurance that the animal(s) are not stolen). It is a common institution throughout the Middle East and Islamic regions of West and East Africa.

In all of the key regional markets, including Nairobi, there are *dilaal* to match sellers and buyers and negotiate prices on their behalf. A *dilaal* works in the market on behalf of both buyers and sellers. The broker can be compensated by both the buyer and seller. The fee is usually around one to two percent of the price of the animal, anywhere between \$1.25 to \$2.50 per animal. In some cases, the fee is cut in half with both the buyer and seller paying part of the

fee; in others the buyer and sellers may be working with different brokers and will pay them separately. For the seller these arrangements remove the burden of finding a buyer and negotiating a price. An older, trust worthy broker may work for several parties simultaneously.

Brokers show an uncanny ability to accurately gauge animal weights, quality, and prices. This is where an experienced trader holds an advantage over younger merchants and explains why many of the major cattle brokers in the region have been in the business for several years. Early attempts by both the Kenyan and the Somali governments to 'rationalize' the system by introducing scales for weighing animals proved futile, as brokers had little use for such expensive devices. In the Nairobi marketplace, for example, Somali traders almost always deal with Somali rather than non-Somali brokers. In Kenya *dilaal* recently have organized themselves into associations in important border markets and have been registered with the local administration.

Dilaal can reduce stubborn market bottlenecks that hurt sellers, whether they are herders or traders. By finding buyers in a timely fashion, brokers can help sellers to avoid the added costs of maintaining the animals until they are sold. In most cases sellers have transported their animals to market over very long distances and, therefore, want to sell them in a timely manner. At the key border market of Garissa, Kenya, merchants must buy fodder and water for their animals when they cannot find a buyer and the herd must remain in the area. A quick sale through a broker minimizes outlays on fodder, water, and hired labor. However, even *dilaal* have little control over external events that can greatly affect the market and the demand for animals. For example, when there is an unexpected glut of animals on the Nairobi market from neighboring countries, such as Tanzania and Ethiopia, Somalia-based traders may have to wait several days in Garissa, Kenya before transporting cattle down country. When this happens, the trader often has little recourse but to purchase fodder or to move animals into surrounding range lands.

Transporters: A third informal practice that facilitates cross-border livestock trade is long-distance trekking. Indeed, one of the most significant and intriguing aspects of the cross-border trade

involves the trekking by foot of cattle over several hundred kilometers, which can take up to several weeks. Trekking is an age-old profession that dates back to the 1800s and the early caravan trade. It takes place along most of the Kenyan/Somali border areas and throughout the Horn of Africa generally. In most cases, cattle are moved overland with three trekkers and an armed security person for every approximately 100 cattle. There is a designated 'head trekker' who is directly responsible to the trader and who may be employed on a fairly regular basis. In southern Somalia, the individual must make payments to pass through territories controlled by different factions and sub-clans, and like the position of *Abbaan* (protector) in the days of the caravan trade, he is responsible for the safe passage of the herd. The head trekker or protector usually comes from one of the main lineages or sub-clans whose territory the market animals must traverse.

The trader is likely to have a young relative accompany the animals on the trek, because of the physical rigor involved, and to safe guard his property. In some cases it can take almost one month to reach a key market from interior locations in Somalia, and substantial animal weight loss can occur. One of the trekkers usually is responsible for procuring rice, flour, sugar, and tea for the trip and serving as the cook. The trader normally covers the cost of food and on long treks an entire sack of flour or rice (50 kg or more) will be purchased and transported on a pack animal (donkey).

There appears to be a functioning market for trekking services in the livestock trade. As would be expected, transport costs per animal generally correspond with distance to market and type of transportation involved (on the Kenyan side, there is some movement by trucks to terminal markets), except where insecurity is particularly problematic. The Baidoa (Somalia)-Garissa and Dinsoor (Somalia)-Garissa routes are examples of the latter and they experience relatively high transport costs. It was assumed that transport costs in the region would have risen exorbitantly throughout the past decade because of insecurity, but this has not been the case for many of the key routes. Movement costs per animal rarely exceed US \$0.01 to \$0.18/kilometer and only modest increases have taken place since the

Somalia government's collapse in 1991. There also were minor differences in transport costs between the Kenyan- and Somalia-based circuits.

To address the concerns of policy makers about cross-border trade, the first tactic should be educational; that is, to instruct (convince?) policy makers about the activity's scale and importance to local and national economies. Only recently has the significant contribution that trans-border livestock trade plays in meeting the consumption needs of the region's large cities received official recognition--albeit modest. As a start, policy discussions of cross-border trade and its importance should be encouraged at the border sites themselves (among customs and government officials of relevant countries), national ministries, and in regional bodies such as the Inter-Governmental Authority for Development (IGAD) in the case of the Horn of Africa. Governments in the region should recognize this and take positive steps to support trans-border activities for the benefit of their economies and citizens. The policy dialogue must occur at these three levels because: (1) the local officials are 'on the ground' in these border sites can play a key role in encouraging/discouraging policies--the isolation of many of these sites means that local officials have a large degree of autonomy; (2) national officials and diplomats must be involved because it requires international agreements and dialogue with other states, and because domestic policies have a direct effect on cross-border trade; and (3) IGAD's involvement is required because it is one of the few organizations in the region with a cross-border mandate and with priorities focused on trade and improved transport links between member states. These three different levels of institutions need to be involved in policy discussions about cross-border trade. Currently there is a local government border committee at Moyale along the Kenya/Ethiopia border that has encouraged local policy discussions about trade and assisted livestock trade when it has been threatened by bans.

Policies that acknowledge and encourage regional trade across borders--rather than discourage it--would capitalize on comparative advantage for different local and national economies; strengthen local food security; increase collection of state revenues and investments in key market and transport

infrastructure; and reduce price volatility and market imperfections. With public resources so scarce and incomes so low in the Greater Horn of Africa, governments should avoid wasting valued resources trying to police a commerce, trans-border trade, that at best they can only very partially control. For at least the foreseeable future, trans-border trade will continue to play a major role in meeting consumption demands in the region and providing livelihoods for large numbers of people.

Empirical Forecasting of Slow-Onset Disasters for Improved Emergency Response: An Application to Kenya's Arid Lands. Slow-onset food crises associated with drought and loss of livestock in Kenya's arid lands routinely require emergency food aid and water distribution, livestock off-take, and other humanitarian intervention projects. Timely and cost-effective interventions depend fundamentally on accurate advance information of evolving situations. Improved forecasts are one essential element of emergency needs assessments and early warning systems. This work reports on a newly developed empirical forecasting model that can predict, with reasonable accuracy and at least three months in advance, the expected child nutritional impact of slow-onset shocks such as drought.

The ability to forecast the onset, duration and severity of droughts, floods, and disease outbreaks with reasonable accuracy, especially in terms of their prospective human welfare effects, is critical to the design of timely and cost-effective early warnings and emergency response systems that can minimize the suffering of populations adversely affected by such relatively slow-onset events. As the consensus on climate change and its consequences grows, there is an increasing worry that the frequency of climate shocks will rise, with more frequent and serious humanitarian crises and ensuing demand for emergency response.

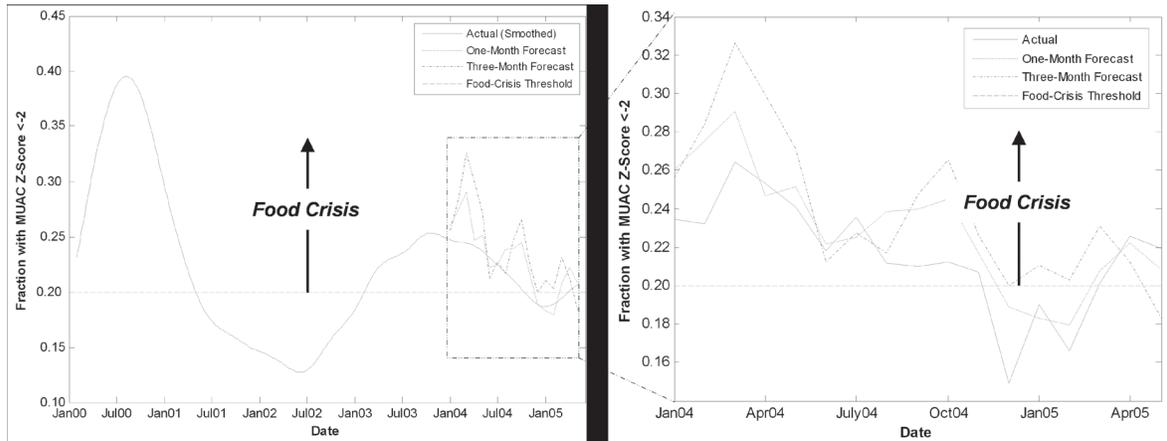
Given the finite resources allocated for emergency response initiatives, there is growing demand for the development of timely, rigorous, efficient and practical methods of emergency needs assessment. To contribute to this effort, the research reviewed in this brief develops an empirical forecasting model to predict the human impact of slow onset disasters for early warning and emergency needs assessment.

The research focuses on the arid lands of northern Kenya. Largely populated by nomadic pastoralists and particularly vulnerable to recurring shocks such as droughts and floods, the region is well-suited for the purposes of this study. As part of an effort to address the vulnerability of the region's population, the Arid Lands Resource Management Project (ALRMP) has been collecting data in various communities across Kenya's arid districts since 1996. Data collected include detailed household-level information on livestock such as herd sizes, mortality rates, lactation rates, managed off-take rates, and child-specific nutritional data, specifically mid-upper arm circumference (MUAC) measures.

The ALRMP data used in this study are monthly observations at the community level collected February 2002 to May 2005 in 54 communities across four districts (Baringo, Marsabit, Samburu and Turkana). The authors supplement the ALRMP data with a rich source of climate and forage availability data collected and produced by researchers of the USAID Global Livestock CRSP Livestock Early Warning System (LEWS) project and its successor, the Livestock Information Network and Knowledge System (LINKS) project. One desirable feature of the LEWS/LINKS data is that they originate with remotely sensed and other data external to communities, so they are information imported into, rather than merely extracted from, the system under study. Lagged values of variables in the ALRMP and LEWS/LINKS data sets, such as changes in livestock fertility, mortality and productivity, and forage and water availability, are combined to predict changes in community-level MUAC measures. The authors designed this study to examine how good a forecast of changing community-level nutritional status we could generate, and with what lead time in order to inform effective response to the prospective human impacts of climate shocks that frequently confront pastoralist communities.

Emergency response to widespread acute food insecurity is largely conditioned by the degree and prevalence of gross malnutrition. Acute food insecurity is typically assessed based on the proportion of children whose anthropometric measure(s) of weight relative to height or age reflect widespread high levels of food stress and acute under-nutrition,

Figure 5 (a,b). Fraction of Children with MUAC Z-score <-2: One and Three Month Forecasts.



commonly known as “wasting.” Mid-upper arm circumference (MUAC), a superior predictor of child mortality, is one such measure. A MUAC Z-score of less than -2 is widely regarded as an indicator of severe wasting. A Z-score is a statistical measure of MUAC values relative to a universal reference population. A Z-score <-2 indicates a child more undernourished than 97.5% of children of similar age. A food crisis might be objectively defined as occurring whenever 20 percent or more of children exhibit severe wasting.

Using this definition of a food crisis, the authors developed a model to forecast child nutritional status (as given by MUAC) based on movements in key explanatory variables several months in advance. Herd dynamic variables (the size of herds, mortality rates, sales and slaughter rates), measures of food aid, as well as variables capturing rainfall and forage availability were used to predict the prevalence of MUAC, and consequently, the likelihood of a food crisis.

Effective response to food crisis requires early warning of emergency conditions so as to mobilize resources. Two forecasting models are developed: a one-month forecast and a three-month forecast for the prevalence of severe wasting. While a one-month forecast will typically be more accurate, the short lead time leaves little leeway for food security managers to make effective use of the forecast. The longer forecast horizon afforded by a three-month forecast, however, comes at a cost of diminished accuracy. The inverse relationship between forecasting horizon and forecast

precision forces an operational tradeoff between models. Different end-users will favor different characteristics and thus different models.

Figure 5 (a,b) shows the monthly forecasts generated for January 2004 to May 2005 compared against subsequent, actual values. Figure 5(a) presents the forecasts superimposed on the full sample of actual values—the proportion of children with MUAC Z-scores <-2. The values are smoothed to highlight trends, especially the considerable variability in the prevalence of severe wasting. A food crisis existed during and following the 2000-1 drought, then re-emerged in 2003-4 in these northern Districts, then began reappearing last year. Figure 5(b) highlights forecast precision by zooming in on the forecasting period and plotting the unsmoothed actual values against the one- and three-month ahead predictions generated by the forecast model.

Three key points emerge. First, recall that a food crisis is defined as the state where 20% or more of children exhibit MUAC Z-scores <-2, reflecting severe wasting. Thus defined, the sample sites regularly experienced food crisis over the January 2000 and May 2005 period, but crisis was not constant. Second, the forecasts trace the actual values quite well, and seem to improve with time, as additional data improves forecast precision. Third, while the one-month forecasts outperform the three-month forecasts, the differences are not substantial.

How can policy makers use such forecasts of

food crisis to make critical emergency response decisions? Furthermore, how confident can policy makers be in decisions they make based on the model's recommendation? To answer these questions, the authors construct a plausible scenario in which the model's forecasts can be used, and offer a measure of forecasting performance.

Consider the case of an organization tasked with responding to food crises. This sort of forecast model can provide early warning of a food crisis at a particular site in the form of predictions of specific levels of severe wasting. The organization can decide on the minimum likelihood of food crisis required before they deploy a costly aid package. This policy decision will depend on a range of variables, including the availability of funds to support emergency response, the operational costs of serving the affected population, logistical considerations regarding access, etc. Once such a threshold likelihood is chosen, the organization might initiate response if the forecast of food crisis reaches or exceeds the pre-determined minimum threshold.

To test forecast performance operationalized in such a way, a minimum response threshold was arbitrarily set at 66% (that is, the organization deploys aid whenever the forecast predicts a 66% or greater likelihood of food crisis). Defining emergency response when there is actually a food crisis, or no response where there is no food crisis, as 'correct' decisions, one can then calibrate forecasting performance by calculating the fraction of correct decisions generated by this decision rule in combination with the forecast model.

Table 3. Model Performance in Generating Correct Decision for Famine Response

Fraction of Correct Decisions	
One Month	Three Month
0.786	0.756

The results, presented in Table 3, are quite striking. Decisions based on forecasts are likely to be correct more than 75% of the time—quite an impressive forecast performance. Moreover, the fairly small depreciation in performance as the forecasting horizon increases shows that these models can be used fairly accurately to provide a reasonable, three-month

early warning to help with emergency response to mitigate the consequences of impending crisis.

Based on data collected from primarily pastoralist communities selected across four districts in Kenya's arid north, the authors have developed an empirical forecasting model that can predict, with reasonable accuracy and at least three months in advance, the expected human impact of slow onset shocks such as drought. Information on herd composition and herd management, climate and forage availability, and food aid flows enable reasonably accurate three-month-ahead forecasting of child nutritional status, specifically severe wasting reflected in very low MUAC levels, with impressive precision. Longer lead forecasts may also be feasible and warrant investigation.

These forecasts were generated from a relatively small subset of variables that ALRMP regularly collects, augmented by data collected routinely by LEWS/LINKS. These data are not overly restrictive or costly to collect. Limiting data collection to these sets of variables, collected consistently through time, might offer a cost-effective way to provide effective early warning to policymakers and emergency response professionals. The precision of these predictions appears sufficiently high that delays in acting on this information due to concerns over forecast accuracy should be limited. However, there remains work to be done to establish how best to communicate this information in as clear and timely a fashion as possible to appropriate audiences.

The authors recommend that the model be adapted as an effective famine early warning tool. As the model can be easily and regularly updated with new information that should continuously increase its forecast performance, a premium should be placed on developing standardized collection procedures and failsafe methods for entering, identifying and storing the necessary data. Such a forecasting model could prove an invaluable tool for early warning and emergency response to food crises.

Activity 3: Building Capacity within FERD at Egerton University

Problem statement and approach. The objective of this activity has been to build capacity within the Department of Natural Resources within the Faculty of Environmental Science and Resource Development (or FERD) at Egerton University in Kenya. Strengthening local universities is an important aspect of capacity building within the GL-CRSP. Our approach consists of providing research opportunities for FERD faculty and staff as well as giving attention to the other aspects of institution building. The latter is focused on creation of a small GIS teaching and research laboratory in the Department of Natural Resources. The main co-leaders for this activity in the past year have been Prof. Aboud and Dr. Layne Coppock.

Progress. In the past year three students have been in the training pipeline, all supervised by Prof. Abdillahi Aboud. First, Mr. Abdillahi Dima Jillo, a PhD candidate in Human Ecology, completed his dissertation on conflict among the Waso Boran of northern Kenya. Mr. Mark Mutinda, also a PhD candidate in Human Ecology, has had to go back to the field to re-collect some data concerning his analysis of risk key resource loss for pastoral and agropastoral divisions in Baringo District. Mr. Mutinda also received a Jim Ellis Mentorship Award in 2004 to conduct his research, and a progress report is provided later in this Annual Report under the Jim Ellis Mentorship Award activity. Finally, Mr. Nicholas Olekaikai, an M.S. candidate in Human Ecology, has also completed his dissertation on the risk of losing key resources for Marigat Division, also in Baringo. Work by Mutinda has a strong GIS component. Mutinda received special training in GIS technology in early 2003, and has become a prime force behind the creation of a 10-seat GIS teaching lab, funded incrementally by PARIMA since the late 1990s.

The outputs remain on track for this activity. The written products in the past year have included two Research Briefs, one master's thesis, and one dissertation. In addition, there were two oral presentations. See Publications and Abstracts and Presentations for details. Below we provide highlights



Ten-seat GIS teaching lab, funded incrementally by PARIMA since the late 1990s. Photo by Mark Mutinda.

from recent research conducted by Abdillahi Jillo as supervised by Prof. A.A. Aboud.

From Herd Diversification to Livelihood Diversification as a Response to Poverty: The Case of the Waso Boran of Northern Kenya. The Waso Boran pastoralists thrived in northern Kenya for over a century. Their traditional economy is based on extensive livestock production. The traditional species raised were cattle, camels, sheep, goats, and donkeys. In addition to providing food for subsistence, livestock has also been an important means to establish social security networks and options for wealth accumulation that were essential for the persistence of pastoralism. Besides the pastoral groups who depended solely on livestock, there were other residents of northern Kenya who depended more on non-pastoral livelihoods in towns and settlements. Before and during the colonial era, the Waso Boran reportedly owned large numbers of all species of livestock. According to various scholars herd diversification among the Waso Boran was a basic strategy for wealth accumulation and risk management. The multi-species livestock combinations played major roles in promoting social and economic welfare. Herd diversification was made possible by the existence of productive, diverse rangelands that had a robust mixture of herbaceous and woody forage species. Hence, the use of multi-species herds was a strategy that allowed effective use of the complex vegetation communities which characterized northern Kenya. The Waso Boran primarily relied on two ecological systems, namely

the Chari and the Waso. The Chari is a scrubland found north and south of Euaso Ngiri river and has been primarily used by browsing goats and camels. The Waso, on the other hand, is a flood plain of the Euaso Ngiri river that stretches to the Lorian swamp. It has been primarily used by grazing cattle and sheep.

Over the last four decades, particularly after the “shifita” wars of 1960s and the drought of the 1970s, the Waso Boran pastoral system underwent tremendous socio-economic transformations. Most notable was the transformation from diverse livestock holdings to diverse livelihoods as a response to poverty. This was reportedly due to land degradation and recurrent losses of livestock. Some scholars have estimated the cumulative losses of cattle over this period at 75%, while that for camels and goats has been estimated at 95%.

Here we report on the results from a socio-ecological investigation that involved 540 Waso Borana households residing in nine locations (Dhedas) in north-central Kenya. Data collection also included a census involving over 5,000 households. Examples have been drawn from this research to document causes and consequences of the transformation of Waso Boran households from

“diverse herds to diverse livelihoods.”

Agro-pastoralism and sedentary pastoralism, which currently characterize the Waso Borana society, are attempts to diversify livelihoods in response to poverty and destitution. This has arisen due to the gradual loss of livestock. A variety of rural and urban dwelling Waso Boran have combined their remaining sheep and goats with non-pastoral enterprises to survive. Thus, most of the households surveyed are currently poor with few animals. As other scholars have noted, a Waso Borana in Kinna and Garba Tulla (the study area) who possessed 60 head of cattle during the 1970s was regarded as well off, while during the days before the “shifita” wars the same person with 60 cattle would have been regarded as “poor.” Per capita livestock numbers have thus dwindled even further over the three decades.

Table 4 shows livestock ownership structure in the study area, and provides evidence of reduced livestock numbers as well as the inequitable distribution of animals. More than 251 households out of the 540 surveyed owned only 6 head of cattle, while a tiny minority (5 households or less) owned most of the livestock (i.e., 19% of the cattle, 15% of the sheep, 18% of the goats, 6 % of the camels, and 49% of the donkeys).

Table 4. Livestock ownership structure for the Waso Boran of Isiolo District, northern Kenya, based on a sample survey of 516 households.

NUMBER OF HOUSEHOLDS	AVERAGE NUMBER OF LIVESTOCK OWNED PER HOUSEHOLD									
	Cattle		Sheep		Goats		Camels		Donkeys	
	No.	%	No.	%	No.	%	No.	%	No.	%
<5	102	(18.9)	79	(14.8)	97	(18.0)	33	(6.2)	265	(49.1)
6 to 10	73	(13.5)	58	(10.8)	88	(16.3)	4	(0.8)	6	(1.2)
11 to 20	72	(13.5)	78	(14.5)	54	(10.1)	3	(0.6)	--	--
21 to 50	77	(14.4)	93	(9.1)	33	(6.7)	2	(0.4)	--	--
51 to 100	44	(8.5)	48	(4.5)	15	(3.0)	--	--	--	--
101 to 150	9	(1.7)	28	(5.1)	11	(2.2)	--	--	--	--
151 to 200	14	(2.7)	23	(4.4)	21	(4.1)	--	--	--	--
201 to 250	1	(0.2)	2	(0.4)	14	(2.7)	--	--	--	--
>251	6	(1.2)	2	(0.4)	22	(5.2)	--	--	--	--

Table 5. Categorization of production systems among the Waso Boran in Isiolo District, northern Kenya, based on a census of 5,126 households.

	STUDY UNIT	PRODUCTION SYSTEMS	NUMBER OF HOUSEHOLDS	HOUSEHOLD CHARACTERISTICS	
				Degree of Mobility	Enterprises
1	Kulamawe	Chari pastoral	420	Mobile	Trade, cattle, shoats ¹ , camels.
2	Kinna	Urban Pastoral	906	Sedentary	Trade, agriculture, cattle, shoats
3	Garba Tulla	Urban pastoral	842	Sedentary	Trade, shoats, camels
4	Rapsu	Agro-pastoral	231	Semi-sedentary	Agriculture, trade, shoats.
5	Malkadaka	Chari pastoral	324	Mobile	Trade, shoats, cattle, camels
6	Gafarsa	Agro-pastoral	502	Semi-sedentary	Agriculture, shoats, cattle, trade.
7	Eres-Aboru	Waso pastoral	396	Semi-sedentary	Cattle, sheep, trade
8	Sericho	Waso pastoral	663	Semi-sedentary	Cattle, sheep, trade
9	Mado-Gashe	Urban-pastoral	842	Sedentary	Trade, shoats, cattle
Total	9	4	5,126	-----	-----

¹Shoats is a term for sheep and goats combined.

For the Waso Boran, livelihood diversification is a pursuit of non-pastoral income to complement their pastoral livelihoods. This can be lucrative or it can be only for survival. The wealthier herders with large numbers of animals pursue livelihood diversification in the non-pastoral economy as a strategy for economic expansion. Herd diversification per se is more of a strategy for spreading risk. The poorest herders are seen to diversify primarily into those non-pastoral options that are more relegated to survival, such as sales of fire wood, gums, charcoal production, and petty trade, as a survival strategy. It has also been observed that diversification options vary according to gender and proximity to towns and settlements. For instance, options for women tend to lie mainly in petty trade, and are undertaken closer to their home settlements, while those options for men lie mainly in wage employment and livestock

trade, which usually occurred far from their home settlements.

As indicated in Table 5, four pastoral production systems have emerged with respect to livelihood diversification among the Waso Borana. These are primarily defined with respect to variation in livestock mobility. They include the sedentary urban pastoral system; the semi-sedentary agro-pastoral

Table 6. Contribution of livestock in the annual household cash economy for the Waso Boran in Isiolo District, northern Kenya, based on a sample survey of 516 households.

LEVEL OF LIVESTOCK CONTRIBUTION	FREQUENCY (%)
Nil/Trace	21 (4.0)
Over 50%	256 (49.6)
Less than 50%	239 (46.4)

system; the semi-sedentary Waso pastoral system; and the mobile Chari pastoral system. The mobile Chari pastoral system is located in two study units, namely Kulamawe and Malkadaka, constituting 14.5% of the total households in the area. The semi-sedentary agro-pastoral and the Waso pastoral systems are located in four study units, namely Rapsu, Gafarsa, Eres-Aboru and Sericho, constituting 35% of the total households in the study area. The sedentary urban pastoral system is located in three study units, namely Kinna, Garba Tulla and Mado-Gashe, constituting 51% of the total households in the study area. The sedentary urban pastoral system is the most common among the Waso Boran today, followed by the semi-sedentary agro-pastoral and the Waso pastoral systems. The mobile pastoral system is relegated to the least common among the herders. The mobile system used to be the dominant system 50 to 100 years ago. The emergence of urban and agro-pastoral production systems reflects livelihood diversification.

The activities undertaken through livelihood diversification include both the traditional pastoral as well as non-pastoral activities, with most of them being relatively marginal. Various forms of petty trade, wage employment, farming (rain-fed and irrigated), the gathering, processing, and selling of wild products such as gum Arabica and miraa (*Catha edulis*), and other endeavors such as the collection and sale of fire wood and charcoal are common. Waso Boran women tend to be more involved in non-pastoral activities than are the men. Table 6 confirms that for the majority (49%) of the Waso Boran, livestock contribute over 50% of the household economy. This illustrates that pastoral and non-pastoral economic activities are co-dominant in the study area.

Traditional herd diversification among the Waso Boran pastoralist was a major coping mechanism against food insecurity, drought and other climatic hazards, supported by access to a diversity of rangelands across northern Kenya. The traditional Waso rangelands with browse and herbaceous forage could support multi-species assemblages of livestock. Currently, the Waso rangelands are characterized by environmental degradation that is in turn caused by population growth and encroachment by other

land uses. This has acted in concert to restrict herd mobility and diversity, and underlies the current trend of heightened resource-based conflict. Inappropriate government policies have been major contributors to these problems. A review of policy should focus on issues such as the legalization of pastoral tenure over rangelands, and the provision of support for community facilitation and capacity building to assist people as they attempt to diversify livelihoods as possible. Attention to viable restocking measures could also be considered. Women need greater attention in the development process, since the transformation in Waso Boran pastoralism has a large impact on women. The role of women changed when they became the main contributors to diversified pastoral livelihoods, and therefore should be the focus of capacity building.

Activity 4: Project Regionalization: Dissemination of Information

Problem Statement and Approach. The information and experiences generated by the PARIMA project have broad applicability to the pastoral regions of eastern Africa and the Greater Horn. On a limited budget, our plan has been to achieve a regional impact of PARIMA via the dissemination of information, both via hard copy mailings, distribution of CDs, and electronic dissemination. We also maintain web sites in the USA to make project-related materials available. The co-leaders of this activity are Drs. Solomon Desta, Layne Coppock, and Chris Barrett. Prof. Aboud, Dr. Getachew Gebru, and Mr. Dadi Amosha play supporting roles in the production and translation of PARIMA UPDATE. Most work in the past year has occurred either at the Nairobi campus of ILRI or at Utah State University and Cornell University.

Progress. We continue to archive electronic versions of all publications generated by PARIMA. We continued to update our project websites at Utah State University and Cornell University. We are also updating the e-mail and mailing addresses for everyone on our regional list of network partners. The list has over 200 entries. Over 300 sets of PARIMA Research Briefs were mailed out using our mailing list in 2006. Over 300 sets of the

popular newsletter PARIMA UPDATE were also produced and distributed in English, Kiswahili, and Oromifa (see Publications). As reviewed in the Annual Report for 2005, the PARIMA project is now formally linked to ILRI via the ASARECA Animal Agriculture Research Network/Crisis Mitigation Office (A-AARNET/CMO) initiative. This will allow PARIMA to gain access to a wider regional network for dissemination of PARIMA materials. A key contact in this regard is Dr. Jean Ndikumana of ILRI.

Activity 5: Outreach and Action Research

Problem Statement and Approach. Provision of supplemental funding to PARIMA from the USAID Mission to Ethiopia since 2000 has allowed us to engage more directly in problem solving concerning pastoral risk management, with a focus on the southern Ethiopian rangelands and adjacent borderlands of northern Kenya. Funds have been provided under the auspices of the Southern Tier Initiative (STI), an umbrella that includes GO and NGO entities involved in pastoral development on the Borana Plateau. The main objectives of this activity are to: (1) build capacity among pastoralists, development agents, and policy makers to understand and implement pastoral risk management interventions; and (2) document best-practice community led projects using monitoring and evaluation protocols. Dissemination of information is an important part of outreach, and is covered under Activity 4 (above). Knowledge, however, can also be generated as a result of applying Participatory Rural Appraisal (PRA) and Action Research (AR) in rural settings. This is distinct from traditional survey research methodologies. Both PRA and AR are methods of investigation whereby power is shared among researchers, pastoral communities, and development agents in the process of sustainably solving local problems. The PRA process is a diagnostic tool to assist communities in identifying systemic problems and locally viable solutions. AR is layered on during the monitoring and evaluation process after the PRA, when pilot interventions have been implemented. AR involves rapid problem diagnosis and intervention to alleviate constraints

if and when community development processes are derailed. Pure outreach activity has been led by Mr. Seyoum Tezera, ably assisted by Mr. Dadhi Amosha. Action research has been guided by Dr. Solomon Desta, Dr. Layne Coppock, Dr. Getachew Gebru, and Mr. Seyoum Tezera. Other leadership for this component is being provided by partners representing the USAID Mission to Ethiopia as well as selected GOs and NGOs including Action For Development (AFD), Save the Children USA, the Oromia Cooperative Promotion Bureau (OCPB), and the Oromia Pastoral Development Commission (OPDC). In the past year, scientists from the Oromia Agricultural Research Institute (OARI) were also being gradually brought into the work.

Progress. We achieved most of our objectives in this activity during the past year. For capacity building, we sponsored or co-sponsored seven events attended by nearly 2,000 people. These included short courses in savings and credit methods, small business development, cross-border linkages between Kenyans and Ethiopians, and exchange tours (see Non-Degree Training). For monitoring and evaluation, the performance of 115 households was evaluated on a quarterly basis across 59 savings and credit groups in terms of measuring success of undertaking new micro-enterprise activities to diversify income. All loan recipients and participants in a non-formal education activity have been monitored for various performance milestones. Effects of cross-border women's tours on the expansion of women's groups and spurring innovative behavior in Ethiopia were documented. All monitoring and evaluation is being conducted in partnership with GO and NGO organizations. This activity has also generated two research publications (including a Research Brief) and 10 presentations (see Publications and Abstracts and Presentations for details). An effort by Layne Coppock and colleagues is highlighted below.

Collective Action by Women's Groups to Combat Drought and Poverty in Northern Kenya. Collective action can be an effective means of local development and risk reduction among rural people, but few examples have been documented in pastoral areas. In 1999, a routine reconnaissance conducted by the PARIMA project in north-central Kenya revealed the existence of very dynamic

women's groups living in some remote settlements. Preliminary interviews suggested that these women, though largely illiterate, were highly organized and engaged in a wide variety of innovative activities. Our main objective for this work was to explore attributes of a broader selection of women's groups across northern Kenya. We wanted to know how groups were formed and governed, as well as what activities they successfully pursue. Can such groups cope with drought and reduce poverty? Are the groups sustainable, and what most threatens their survival? A large (i.e., 70-question), semi-structured questionnaire was administered to representatives of 16 women's groups in Moyale and Marsabit Districts in northern Kenya. The groups were purposively selected from key locations readily accessible to data collectors. Interview questions were typically open ended and elicited qualitative responses. Interviews were conducted in Kiswahili and took about one day per group. At the conclusion of each interview, group administrative and financial records were inspected and physical assets inventoried to confirm interview claims. While the women we interviewed represented dominant pastoral ethnic groups in the region (i.e., Boran, Rendille, etc.) they all currently pursued sedentary lifestyles.

Group Formation and Governance. The 16 groups we interviewed were an average of 9.7 years old (range: 2 to 19 years). The number of charter members per group averaged 24 (range: 7 to 42), with 100 percent females. About 85 percent of charter members were illiterate (range: 60 to 100 percent). On average, the distribution among "wealthier," "intermediate," and "poorer" charter members was 17, 31, and 52 percent, respectively. Most groups were formed to improve livelihoods of the members (80 percent of responses). About half the time groups were formed after people got the idea from a GO or NGO; these could provide guidance on how to create effective groups as well as give material or financial support. The other half of the time people largely decided to form a group from observing the success of existing groups. Charter members for groups were often selected following public meetings with minimal screening criteria. In other situations, however, charter members had well-defined, common goals—such as a desire to

engage in dairy marketing, for example—or were bonded by specific religious affiliations. Most groups have gradually restricted their recruitment of new members over time. Applicants are carefully screened based on trustworthiness and aptitude for teamwork. The ability to bring new skills to a group can be important for an applicant. Applicants are interviewed and a vote of the membership is often taken for final admittance; there may also be a probationary period. Entry fees are common and range from KSh 500 to 6,000 (e.g., USD 6 to 80) per person. There are formal procedures if a person dies or wants to leave a group. All groups are self-governed with reference to a constitution and by-laws. In most cases, groups received assistance from GO or NGO partners to help draft such documents. Despite a high rate of illiteracy among members, groups take pride in having detailed memorized knowledge of their constitutions and by-laws that outline leadership structures, personal rights and responsibilities of members, the philosophy in serving the community at-large, and administrative and operational procedures. Group officers typically include a chairperson, secretary, treasurer, and a management committee. Responsibilities of members focus on attending meetings, contributing labor to regular group activities (i.e., operating a farm, lodge, grain mill, dairy, shop, etc.) and any other irregularly assigned duties, making monthly payments to group accounts, and actively supporting important community functions. Less commonly mentioned responsibilities include assisting the poor or infirm and helping with group record keeping. Members have a duty to be informed voters with respect to the election of leaders and their participation in decision-making processes. Privileges of members focus on their participation in profit sharing and savings and credit (micro-finance) activities. Members acquire loans at negotiated repayment terms, and can have reliable access to supplemental funds to help cover costs for child education, medicines, hospitalization, child birth, funerals, weddings, and restocking animals. Group membership allows for assistance with home construction and access to group-owned technology as well as employment at group-owned businesses. Group members have priority access to training and other capacity-building events.

Table 7. Summary of the most important collective actions for 16 women's groups in northern Kenya.

Group No.	Most Important Collective Actions
1	Savings and Credit: Through the revolving fund all group members have bought goats which have multiplied; this has improved milk production for group members. Through the same revolving fund many group members have purchased household items such as drinking glasses, forks, mattresses, etc. The group members also have borrowed money to educate their children and many have benefited. From the sale of crops the group has increased its income which is used to make loans to the group when they are in need. The group has draught oxen that can be hired at a lower rate for group members and they also provide service for the community.
2	Income Diversification and Capacity Building: The group acquired a camel for milk production thanks to external support. They have also constructed a campsite, a small dairy operation, a health center, a meeting hall, bakery, and small farm all for income generation. Profits are distributed as 70% to the individual and 30% is deposited into the group account. The group member have attained skill in management and production of processed items. The group supported construction of pit latrines and rehabilitated wells. The group has toured and exchanged views with other groups. The group has sustained itself for 11 years. The group has marketed their goods to Nairobi.
3	Savings and Credit and Improved Living Standards: Twenty-four members have taken loans for KSh 10,000 each. The group has supported 10 members to build new houses at KSh 2,500 each. The group has supported 10 members to purchase new mattresses KSh 1400 each. The group supported five members by purchasing a metal box for KSh 800.
4	Savings and Credit, Education, and Improved Living Standards: The group has extended loans to 10 members at KSh 10,000 each. The group has paid the school fees for two of the member's children at KSh 1,000 each. Hospital bills have been paid for two members at KSh 3,000 each. Houses have been constructed for 25 members at a total cost of KSh 515,000. Maternity benefits have been provided for 26 members at KSh 1000 each. Fifteen goats were purchased to support community projects at a total cost of KSh 22,500.
5	Savings and Credit, Restocking, Education, and Improved Living Standards: Group account used to restock nine members for a total cost of KSh 72,000. School fees paid for the children of four members at KSh 5,000 each. Payments to offset hospital bills for two members cost a total of KSh 8000. Purchase of household furniture and other item for members at a total cost of KSh 30,000.
6	Income Diversification, Savings and Credit, and Improved Living Standards: Development of a dairy marketing scheme has been important. Some group members have educated their children from sales of milk. Group members contribute KSh 100 per month to a group account. The sum is given to one member. This helps the members purchase livestock like donkeys and goats, build houses and collect household items. Five group members have started a small trading activity from the sale of milk. These activities have improved the income of group members. There is a significant improvement in the hygiene of group members as their quality of life has improved.
7	Savings and Credit, Improved Living Standards, and Income Diversification: The weekly collection of KSh 5.00 from group members was used to buy household items for the members. So far the group members have bought three sets of drinking glasses at KSh 600 and bed sheets for KSh 500. The profit from the sale of items produced by group members such as beds, traditional milk containers, and floor mats are shared by the group while the initial capital is used to buy materials for more production.
8	Savings and Credit, Education, Improved Living Standards, Emergency Support to the Poor: Group savings used to restock members with goats for a total of KSh 105,600. Partial support of home construction for 13 members cost a total of KSh 130,000. School fees and transport costs for children of members to attend high school has cost KSh 48,000. Household furniture has been purchased for four members at a cost of KSh 20,000. Hospital bills for members have been paid at a total of KSh 3,000. Loans to 20 members have added to KSh 100,000. Emergency loans have been provided to the neediest members, and this has added to KSh 60,000.
9	Savings and Credit, Restocking, Education, Improved Living Standards: Hospital bills have been paid for three members at a total of KSh 12,000. Provision of soft loans to 18 members for a total of KSh 45,000. Support to a community water project at KSh 10,000. Restocking of community members at a total cost of Ksh 10,000. Educational funds for children of members has been funded at KSh 4,000.
10	Income Diversification, Savings and Credit, Improved Living Standards, Restocking: Diversified income source for members has yielded KSh 15,000. Payment of hospital bills for six members has cost KSh 16,000. Social events for members cost KSh 4,000. Livestock purchases have added to KSh 24,000.

(continued next page)



(Table 7. Continued from previous page)

Group No.	Most Important Collective Actions
12	Savings and Credit: Restocked 13 members with goats for a total of KSh 30,000. Provided loans to members for a running total of KSh 97,000. Hospital bills paid for members for a total of KSh 50,000. Construction of water jugs for group-form members for a total of KSh 64,000. Shared profits/dividends of group activities to members for a total of KSh 20,000.
13	Land Purchase, Commercial and Residential Buildings, Education, Savings and Credit: The purchase of a plot of land for commercial use by group members has been one of their biggest achievements; this has increased the asset base for the group. The plot cost the group KSh 120,000. The group has just started construction of a commercial building at an approximate cost of KSh 120,000 and construction is on-going. The group also purchased a residential plot at KSh 50,000 and plans to construct a nursery school to improve their income. The group does not have any other income-generating activity at the moment and is only involved in managing a revolving fund.
14	Income Diversification, Improved Living Standards, Restocking, Education: The group is involved in production and sales of beadwork, both locally and internationally. There is significant improvement in the quality of life of members since inception of the group. The group was formed to improve the income of poor members. On average a member can get KSh 4000 per month from sales of beadwork. The group members have benefited from NGO support. As a result of increased income members have been able to purchase household goods, goats and sheep, and clothing and food. They can also pay school fees for their children.
15	Savings and Credit, Education, Assistance for the Poor: Provision of loans for six members have added to KSh 25,000. Hospital bills have been paid for three members for a total of KSh 15,000. Shared profits /dividends from group projects for 20 members have added to KSh 7,000. Contribution have been made to public fund raising for school projects for a total of KSh 10,000. Assisted in paying for funeral for an old mother at a cost of KSh 6,000. Assisted another needy community member with KSh 800.
16	Savings and Credit, Education, Improved Living Standards: Provided loans to 15 members for a total of KSh 45,000. Assisted member's children in paying secondary school fees, with five children for a total of KSh 25,000. Off-setting hospital bills for five members for a total of KSh 15,000. Provided housing for members through purchase of 10 corrugated iron sheets for a total of KSh 4000. Purchased donkeys for group members for a total of KSh 6000. Shared profits/dividends among 20 members for a total of KSh 65,000.

Activities, Sustainability, and Future Plans of Groups. Major objectives of groups included reduction of poverty by increasing incomes via micro-enterprise development and livelihood diversification (Table 7). Initial activities often focused on group involvement in farming; respondents noted that farm produce could be sold quickly and was profitable. Dairy marketing, poultry marketing, and a variety of micro-enterprises (butchery, hides and skins, honey, bakery, handicrafts, etc.) were also pursued as initial income-earners. Profits from all of these activities were then deposited into the group accounts, or invested in livestock production or purchase of key technologies like grain milling equipment. Sums in the accounts of groups were also increased via regular personal contributions and accrued interest from group members. After a few months, pooled funds could start to yield loans for more and larger spin-off activities. Group members also coordinate public fund raisers (*Harambee*) to accumulate larger sums of money to support emergency needs of

orphans, the elderly, and infirm; such funds could also be used to construct group meeting halls, lodges, and school facilities. Groups are indeed able to accumulate large sums of money over several years of careful planning and investment. Group efforts to mitigate drought impacts have also evolved over time; these have included provision of water and food for the neediest members, goat restocking, and extending low-interest loans. Group characteristics that promote sustainability reportedly include unity of purpose, transparency and accountability of leadership, and making good business decisions that lead to diversified micro-enterprises. The ability of a group to secure external funding, training, or technical support from development partners was also regarded as important for sustainability. The factors that most readily lead to the failure of a group, include negative internal dynamics such as poor leadership, uncooperative members lacking shared vision, and mismanagement of group funds. One negative external factor of note was political

Table 8. Important future plans for 16 women's groups in northern Kenya.

Group No.	Important Future plans
1	Construct water tank to sell water. Construct more houses for group members. Purchase more draught oxen and loan to group members
2	Construct a small shop to sell foodstuffs. Construct a dip for livestock. Construct a curio shop
3	Build a high school. Construct training center in our lodge. Increase the seed money for loans to members. Construct more houses.
4	Construction of a group lodge and a restaurant. Improve shelter for 13 members. Increase group capital. Expand income-generating activities and livestock trade
5	Restocking. Improve shelter for members. Provide members with children's school fees. Construct a vocational training center. Purchase a vehicle to be used as a taxi. Construct a private nursery school
6	Construct a dairy. Buy livestock from the profit accrued from the dairy. Support individual members to start businesses through loans.
7	Raise more funds to give loans to group members. Build an office, a shop, and a meeting hall. Buy a tractor to collect firewood to reduce work for women
8	Construct an underground water tank. Build a grain mill. Buy a photocopy machine and a generator. Improve shelters for members. Establish a vocational training center for girls. Construct a water cistern for members. Assist with payments for school fees for children of the poor
9	Purchase of grain mill. Expand livestock trade and other income generating activities. Establish an orphanage for HIV/AIDS victims.
10	Construction of lodge and hotel. Construct a water tank. Start a butchery business. Purchase of camels and donkeys for transport and hauling goods. Buy a pair of draught oxen). Start trade in hides and skins.
11	Construct a water tank. Construct a meeting hall. Establish a revolving fund to construct houses
12	Construct a lodge. Construct a new water tank and rehabilitate an existing one. Venture into the livestock trade. Improve shelter for members. Buy a vehicle to use as a taxi.
13	Organize a Harambe for construction of a shop. Construct a nursery school. Increase the amount of our revolving fund.
14	Improve marketing of beadwork. Explore other income-generating options, Build houses for group members.
15	Construct a lodge and social hall. Restock members. Improve shelters for members.
16	Buy a grain mill. Expand the livestock business. Construct a lodge. Restock group members. Improve shelter for group members. Purchase draught oxen for group farm

incitement or interference. Future plans of groups are diverse but ambitious. Aspirations are dominated by hopes to create more physical structures, be they improved houses for members, meeting halls, shops, schools, training centers, health centers, or water tanks (Table 8, page 24). Entrepreneurial actions are prominent, and include plans to purchase vehicles, draught oxen, electric generators, and even a photocopy machine. There were several instances where groups sought to expand savings and credit operations. Our groups noted that good group governance is the key to success.

We have been impressed by the achievements of these women's groups. The groups are very similar

despite great distances that separate them. The important roles of collective action, micro-finance, micro-enterprise, and income diversification were repeatedly observed. Although the economic impact of building social capital via these groups was not quantified, we would speculate that it seems to be enormous. A synergism exists among efforts to build social, human, and economic capital in these groups. Such collective action has important roles in community risk management, especially when government is unable to provide safety nets or insurance. We believe that development agents should support these group efforts whenever possible. Groups need small grants and technology as well as

capacity building in leadership, group dynamics, micro-finance, and micro-enterprise. Policies that promote investment in rural development—prominently including improvements to physical infrastructure, reducing insecurity, increasing access to education, improving governance, and promoting cross-border trade, would also benefit groups at the local level by expanding economic opportunity.

Activity 6: Sustainable Engagement with Policy Makers

Problem Statement and Approach. Policy decisions often have large ramifications for pastoral people in Kenya and Ethiopia. The voice of pastoral people, however, is usually not heard in policy deliberations. The PARIMA project has gradually engaged policy makers over the past few years through the dissemination of written information as well as via field tours and workshops. The PARIMA project began a process of directly engaging policy makers as a result of meetings convened in Nairobi and Addis Ababa during August 2003. Work during the past year has been a low-level continuation of efforts begun in 2003-04 that has focused mostly on the dissemination of project information (see Activity 4 above). In addition, we work to build bridges and affect policy-related thought through formal and informal engagement, either in the context of small meetings or one-on-one contacts. The goal is to better-inform decision makers with respect to pastoral issues, and in turn better-inform PARIMA as to what issues decision makers see as their most important needs to enable more effective decision-making. This involves a prolonged effort. The co-leaders for this activity in the past year have been Drs. Getachew Gebru, Dadi Amosha, Solomon Desta, Layne Coppock, and Prof. A. Aboud. The location of work is broad within our host countries, including rural areas in northern Kenya and southern Ethiopia as well as efforts in the capital cities of Nairobi and Addis Ababa. On-going efforts by Drs. Chris Barrett, Peter Little, and John McPeak to engage multi-lateral institutions, such as the World Bank, or USAID Missions, are also very important to this end.

Progress. We tend to make more inroads with policy makers in Ethiopia compared to those in Kenya. This is because of our large outreach activity in Ethiopia co-sponsored by the USAID Mission in Addis Ababa and the professional and personal linkages between Ethiopian officials and PARIMA staff such as Dr. Getachew Gebru, Dr. Solomon Desta, and Mr. Dadi Amosha. Kenyan policy makers are less accessible to PARIMA than those in Ethiopia. Kenya has recently produced a new policy document relevant to Kenyan pastoral lands. There is considerable dialogue occurring within the new NARC government in Kenya concerning pastoral lands, as well as optimism that investments in infrastructure for pastoral areas will eventually occur. A wide variety of special interest and advocacy groups engage the Kenyan government with respect to pastoral development. The comparative advantage of PARIMA in affecting pastoral policy debate has thus been lower in Kenya compared to that for Ethiopia, where the number of advocacy groups is much lower. PARIMA has several outputs this past year, however, that relate to policy matters. One policy-related achievement in Ethiopia has been the recent role of PARIMA in promoting the liberalization of official attitudes towards a reinstatement of prescribed fire for rangeland management on the Borana Plateau. What had been previously thought to be “official policy” in the form of bans prohibiting local use of fire since the 1970s was actually just an assortment of “unofficial attitudes” of certain decision makers. There have been recent official pronouncements in the Regional State of Oromia clarifying the policy situation and allowing pastoralists to engage in prescribed burning. This has largely been a result of momentum and publicity associated with a PARIMA-sponsored fire course in February 2005. Other incremental progress has been made in Ethiopia in terms of involving policy makers in pastoral livestock marketing debates and the creation of livestock marketing chains (see Desta et al. 2006 under Publications). Finally, dozens of copies of PARIMA Research Briefs were distributed in 2006 to parliamentarians in both countries who affect pastoral policy.

Activity 7: Building Capacity of KARI and OARI in Pastoral Research

Problem Statement and Approach. One of the important aspects of the GL-CRSP is to build capacity among national research organizations, and that is the main objective of this activity. We have already been contributing to this goal on PARIMA by offering formal degree-training opportunities for Kenyans and Ethiopians at the MS, PhD, and post-doctoral levels. We see other opportunities, however, to build capacity among rank-and-file researchers at the Kenya Agricultural Research Institute (KARI—Marsabit, or otherwise known as the National Arid Lands Research Center) and the recently created Oromia Agricultural Research Institute (OARI—Yabelo). To this end we have started the process of linking KARI—Marsabit with OARI—Yabelo to begin a process of cross-border research, training, and collaboration.

Progress. Overall, this activity produced four research outputs including two Research Briefs and one master's thesis. The co-leaders of this activity include Drs. Solomon Desta, Getachew Gebru, George Keya, and Lemma Gizachew, and Mr. Aliye Hussien. Dr. Layne Coppock provides guidance as needed. There were four specific non-degree training events with 96 attendees (see Non-Degree Training). A summary of one Research Brief by Dr. Getachew Gebru and OARI colleagues is below, followed by another by Mr. Sintayehu Meselle of OARI, who completed his master's degree in 2006.

Public Engagement in the Prioritization of Pastoral Research: The Case of the Oromia Agricultural Research Institute, Ethiopia. Researchers are beginning to alter their role in the rural development process. The traditional approach has been what is called “research and development” whereby researchers are in control of a pipeline for producing technological innovations. In contrast to this approach, there is a new model called “research for development” that emphasizes an iterative, adaptive nature of innovation in complex systems, achieved through systematic enquiry combined with mutual learning among researchers, development practitioners, and local communities that is fundamentally based on action and engagement. The recently opened Pastoral

and Agro-pastoral Research Center of the Oromia Agricultural Research Institute (OARI) at Yabelo, Ethiopia, took a major step towards the “Research for Development” model in its design of pastoral research programming. It began by holding a public meeting with various stakeholders to prioritise the research agenda. Here we will outline the approach that was used to engage stakeholders in problem identification and highlight outcomes from a two-day meeting held August 6-7, 2006, that led to the finalization of a working agenda for the research center. Participants at the workshop were drawn from pastoral and agro-pastoral communities, women's cooperatives, traders, pastoral development offices, and NGOs operating in the Borana Zone. Districts represented on the workshop were Yabelo, Arero, Dire, and Miyo.

The springboard for the gathering was the commitment from OARI and Oromia Pastoral Development Commission (OPDC) to creating a genuine, locally demand-driven research agenda with a focus on applied and adaptive work. To help meet this goal, a proposal for such an approach was developed. The proposal was approved by OARI and OPDC, with PARIMA as a partner. The main components of the proposal included the following:

- (1) Identification of priority needs for the targeted community;
- (2) Identification of the researchable priority needs. Research would also be categorized according to applied and/or adaptive aspects; whether it was disciplinary or multi-disciplinary; time frame (long-, medium-, or short-term); whether it was quantitative or qualitative, etc. It is a creative and analytical process because a given research topic may directly or indirectly bear on major problems, and the critical nature of certain research needs to be accurately identified; *the wheel should not be re-invented*;
- (3) Identification of special training needs that support identified research and/or outreach. This includes degree or non-degree options;
- (4) Develop and review proposals to deal with researchable or outreach priorities. The proposals are to be reviewed based on relevance and on opportunities to link research and development perspectives. This is to be mediated via the Research

Table 9. Ranking of priority research problems in the pastoral production systems.

TOP RESEARCHABLE PROBLEMS RANKED FROM HIGHER (1) TO LOWER (5)	REMARKS
1. Improve availability of livestock forage (grazing)	Forage losses directly related to bush encroachment, expansion of termites, and other types of land degradation; indirectly related to heavy livestock pressure on natural resources that is related to an increasing human population
2. Improve and expand water harvesting methods	Need to develop appropriate techniques to better capture run-off and improve management of water points
3. Reduce effects of common livestock diseases like Foot-and-Mouth (FMD)	FMD especially affects cattle and sheep. Causes high rates of lamb mortality
4. Improve pastoral livestock marketing	Risks associated with live-animal trade are most important; cattle market in particular is struggling; other constraints for local marketing and processing of dairy products; poor availability of disaggregated price data for livestock.
5. Reduce negative effects of crop cultivation on loss of dry-season grazing	Expansion of cultivation is reducing access to key dry-season grazing

and Extension Advisory Council at the district level. At the local level, a panel review of proposal briefs that includes researchers to assess scientific merit, as well as community representatives and officials (woreda, OPDC, NGO, etc.) to assess development relevance. Then, surviving proposals could be revised and sent on to regional and federal levels as required;

(5) Implement both aspects of the program (research and development); and

(6) Once this program is well underway and problems worked out, research development of a similar step-wise process at the Ethio-Kenya border by OARI and KARI.

In this report only the first component—research prioritization in relation to priority needs of the targeted community—is discussed. The subsequent components of the proposal are in progress. The targeted communities for research and development prioritization were identified from the eight pastoral and agro-pastoral districts of Borana Zone. A group of 50 representative stakeholders were convened for two days. They were carefully facilitated to develop a prioritized list of needs at the proper sub-regional scale. A modified PRA-type approach was employed where participants in breakout groups were asked to do problem listing and rank priorities based on pair-wise ranking. Important observers were invited, including local and regional administrators. Breakout groups consisting of pastoralists; researchers, and

other development actors were created to help reduce the chance that a few people could dominate the discourse. Plenary and group discussions and the use of the modified PRA resulted in prioritization of the major issues (Table 9).

The problems associated with scarcity of livestock forage were considered by pastoralists to be the most important area of technical research. Availability of pasture/feed for livestock is increasingly becoming a serious concern in recent years. Factors like bush encroachment, termite damage, proliferation of private grazing enclosures (*kalo*), expansion of crop cultivation, land degradation, ban of fire, and population pressure were noted as the factors aggravating the decline in the availability of grazing land. One key driving variable was pointed out as human over-population, but there are few short-term solutions for dealing with this issue.

Bush encroachment is the most serious threat to rangeland productivity in the Borana rangelands as perceived by stakeholders. Tackling bush encroachment was thus rated highly. Not all woody species were considered harmful, but there are some species that inhibit under-story grass growth and obstruct the mobility of livestock. Some of the thorny species also cause damage to skins, hides, and teats. Species like *Acacia drepanolobium* was reported to be fast spreading, and this shows variable response to management that involves manual cutting and clearing.

The spread of termites is another challenge in the rangelands. It is only second in importance to bush invasion in terms of affecting grazing resources. Herbaceous biomass that is not reduced by bush is either consumed by termites or covered by the expansion of termite mounds. The magnitude of the threat, however, varies from place to place.

Another priority concern is the prevalence of land grabbing for crop cultivation or fodder enclosures (*kalo*) for calves. There is a growing tendency to fence-off formally open-access grazing land in the pretext of crop production, while in reality this fenced land is ultimately used for private *kalo*. The expansion of private *kalo* has barred pastoralists' access to the range resources that traditionally belonged to the community. Worse of all in this context is that some individuals with no livestock have started to enclose grazing land for the purpose of selling forage.

The expansion of cultivated crops (like maize) into the rangelands did not come out at the top of the rankings. However, during plenary discussions the participants indicated that the expansion of crops has put pastoral life at great risk. Reportedly, crops spread along the bottomlands where soil moisture is higher. This position on the landscape is also where productive grasslands are traditionally found, particularly species that are useful for dry-season grazing (*Pennisetum* spp). The pastoralists emphasized that if crop expansion is not checked soon, potential dry-season grazing areas will be totally reverted to crop production. It is suggested that the urgent demarcation of rangelands into appropriate land uses will avoid unnecessary competition between the two enterprises.

Although soil erosion was mentioned as an important factor in reducing rangeland productivity, there is no known tradition of soil management in the region. Soil erosion has occurred on the Borana Plateau for many years. Heavy rains at higher elevations create runoff that leaves behind gulleys. The area along Finchawa, Surupa, and Dida Hara were mentioned as examples of gully erosion. Yet there is still no effort to contain the problem. The pastoralist, therefore, identified the general topic of soil erosion as one requiring research and development intervention.

The use of fire as a management tool has a long history in the southern rangelands. It is a means by which pastoralists manipulate the composition of the range vegetation and control ecto-parasites and associated livestock diseases. Pastoralists indicated that the fire ban in the rangelands since the 1970s has resulted in the build-up of woody species, ecto-parasites (particularly ticks), wild predators (hyena), and poisonous reptiles. Even if the controlled fire ban in the rangelands is fully lifted, its widespread application could be complicated by increased human settlements and the sharp rise in human population.

Water remains the most limiting resource for the pastoral and agro-pastoral communities of the Borana Plateau. Grazing animals have to be trekked for long distances to drink water. This is the most daunting task for the Borana community and as a result it was ranked first as a problem. Communities realize that huge amounts of water in rainy seasons are lost as run-off. Developing effective techniques to capture rainwater, and minimizing after-effects of heavy run-off were pointed out as important areas of research. In effect, run-off management is ranked second by the participants. Water from some of the volcanic craters constitutes an important water source in Borana. But the paths leading down to such water points are often steep and pose difficulties for reliable livestock access. This is particularly true for animals weakened by forage scarcity during drought. Developing engineering interventions to overcome such accessibility problems were noted as a priority.

Among major problems, livestock disease was ranked third. Generally, disease appears to be the major challenge in all classes of livestock kept by pastoralists, although Foot and Mouth Disease (FMD) in cattle is reported as the most serious disease in the region.

Among problems raised with respect to markets, the risk associated with the live-animal market was regarded as the most important. Pastoralists say that the level of risk is particularly high for cattle, as market prices for cattle are unpredictable. They indicated that the availability of market information, as disaggregated by sex, age, and condition prior to their arrival in the market places,

is important to minimize risk. Milk marketing and processing constraints came in second as a marketing problem.

It is highly likely that when priorities are revealed, the most important ones may deal with development rather than research. It is therefore important that if a truly new approach is to be embraced, that an alliance among research and development agents be formed to effectively cope with the major requests that emerge. Given more development resources are being pushed down from the federal to the district level, district administrators are becoming vital links in the process. District administrators can recast their next budget request with respect to priorities voiced at the meeting.

The call for using pastoral and other stakeholders' knowledge in designing appropriate research, development and extension strategies is gaining momentum. However, in practice, involving pastoralists in research has been generally limited to having them passively participate in questionnaire surveys and providing lists of "indigenous technical knowledge." Such an approach misses much of the deeper understanding developed by pastoral and agro-pastoral communities as managers of their production system and local environment. Engaging these communities in discussions and understanding their strategies allows a framework for posing better technical questions for research. It also provides the basis for evolving development strategies that are not imposed as "alien packages," which contradict existing practices. Understanding livestock management strategies, their environmental classifications and understanding of ecological processes, could lead to proposing better scientific questions and stronger links of such questions to development solutions.

Our results indicate that there is great value in including local communities and other relevant stakeholders in the process of research problem identification and technology generation and transfer, as this will promote uptake of new technologies and management practices. This process of participatory identification of research problems is serving as the starting point for the anticipated strong integration and partnership among pastoral and agro-pastoral communities, development workers, and researchers.

Furthermore, the initiative will help carry out more action-oriented and focused research in the pastoral and agro-pastoral areas, and bring better linkages between research and development.

Changes in Land Cover and Rangeland Condition in Yabello District of the Borana Rangelands. It has been theorized that the livelihoods of people on the Borana Plateau have changed considerably in recent decades. The Borana people, in particular have probably shifted from a heavy dependence on pastoralism to agro-pastoralism in some areas. Maize cultivation has emerged in recent decades on the plateau, and some investigators suspect that it may be expanding dramatically as the Boran cope with population pressure and food insecurity. For example, some published evidence suggests that cultivation has increased from 5 to 16 % of the land area of the Borana Plateau over the past 15 years. Other changes in land use or land cover are also reportedly occurring. These include privatization of forage sites (*kalo*), bush encroachment, and general ecological degradation. These trends can all have a negative impact on the grazing capacity of the system, and are hence detrimental to pastoralism. The Borana pastoralists will be less able to support themselves via livestock production, and be less able to supply livestock and livestock products to markets, if such trends continue. It is therefore important to document land use and land cover changes in support of appropriate land use planning. The present study was designed as a student research project. The objective was to assess land use/land cover dynamics in the Yabello District of the Borana Plateau over the past 30 years. Another important question is to what extent changes in land use or land cover are reflected in soil physical and chemical properties. Topsoil is a non-renewable resource and it must be managed carefully to promote sustainability of forage, livestock, and crop production. Some physical and chemical properties of soils are useful indicators of soil degradation. Yabello District is one of five districts that comprise the Borana Zone. It is situated 570 km south of Addis Ababa and is about 400 km² in size.

Spatial and temporal changes in land use and land cover were quantified at three intervals over the period 1973 to 2003 using remotely sensed

Table 10. Change in land use/land cover for Yabello District between 1973 and 2003 as interpreted from satellite images.

Land Use/Land Cover Class	1973		1986		2003	
	Area (km ²)	%	Area (km ²)	%	Area (km ²)	%
Bushlands	80.0	20.0	100.0	25.0	115.0	28.8
Bushed-grasslands	134.0	33.5	161.0	40.3	198.0	49.5
Grasslands	173.0	43.3	106.0	26.5	24.0	6.0
Croplands	13.0	3.3	33.0	8.3	63.0	15.8
Total	400.0	100.0	400.0	100.0	400.0	100.0

Table 11. Percentage change in land use/land cover for Yabello District between 1973 and 2003 as interpreted from satellite images.

Land use class	Area in 1973		Percent change in land use		
	(km ²)	%	1973-1986	1986-2003	1973-2003
Bushlands	80	20.0	+25.0	+15.0	+43.8
Bushed-grasslands	134	33.5	+20.1	+23.0	+47.8
Grasslands	173	43.3	-38.7	-77.4	-86.1
Croplands	13	3.3	+153.8	+84.8	+384.6

data. Landsat images were collected for 1973, 1986, and 2003. Preliminary image interpretation was checked and adjusted via ground truth methods. Data interpretation and analysis were conducted using GIS software including ArcGIS version 9.0 and ERDAS IMAGINE version 8.6. Temporal change patterns over time were automatically produced once the software was calibrated and results were expressed in terms of changes in aerial extent and percentages against a baseline reference map. This approach resulted in the analysis of four basic land uses/land cover types: (1) grassland; (2) bushed grassland; (3) bushland; and (4) cropland. The grasslands are typically used for livestock grazing. They tend to be open areas with good visibility on flat areas and hill slopes dominated by perennial herbaceous plants with scattered small shrubs and trees; another descriptive term would be mixed savanna. The bushed grasslands are former grassland sites where woody shrubs and trees have increased in density to be co-dominant with herbaceous plants in terms of cover. The bushlands are those sites where woody cover is fully mature and herbaceous plants have been almost eliminated. The croplands tend to be drainage sites where moisture accumulates and crops of maize can be grown. Traditionally, such sites have produced

perennial grasses for dry-season grazing.

Soil sampling was stratified across the four site types, with three replicates per type. Composite samples were taken using a coring tool from the surface (0-20 cm depth). Each composite sample was comprised of 20 sub-samples selected in a restricted-random fashion according to landscape position and slope. Composite soil samples were transported in plastic bags and processed at the National Soils Laboratory in Addis Ababa. Soil samples were analyzed for standard physio-chemical properties.

Tables 10 and 11 illustrate land use/land cover trends for Yabello District between 1973 and 2003. Dramatic declines in the grassland type were observed, while cropland increased five-fold and both the bushed-grasslands and bushlands increased substantially. These empirical results support perceptions that grazing land has been lost to crop cultivation and bush encroachment generally. The increase in cultivation is the result of several factors. First, recurrent droughts and major death losses of milking cows due to starvation create significant periods of food insecurity for pastoralists. Lack of milk forces them into cultivation, in order to produce calories to fill the gap. Growing their own maize also means that the pastoralists do not have

Table 12. Mean values of physical properties of soils as affected by land use/land cover.

Land use type	*Textural classes (%)			Tex. class	BD (g cm-3)*	COMP (kg cm-2)
	Sand	Silt	Clay			
Grasslands	39b	25a	36a	CL	1.37b	1.85d
Bushed-Grasslands	52ab	14b	34a	SCL	1.60a	3.11b
Bushlands	71a	9b	20a	SL	1.70a	4.35a
Croplands	40b	22a	38a	CL	1.42b	2.64c
LSD (0.05)	21.8	5.9	18.9	-	0.23	0.16
SEM (+)	8.92	2.42	7.70	-	0.09	0.07

to sell what few stock they have left to buy food. Secondly, due to the gradual change in livelihoods, the Borana have probably become agro-pastoralists in some areas and plan to grow maize as a routine part of their production system. Third, increased access to seeds via local markets may facilitate cultivation as well. Bush encroachment is recognized as one of the biggest threats to the rangelands of the Borana Plateau. Lack of fire and heavy grazing on residual savanna are probably contributing factors to the increase in woody vegetation. The pastoralists reportedly have been unable to use managed fire to control bush since the 1970s. Reoccurring drought may also contribute to vegetation change. Another important indirect cause of bush encroachment is population pressure. The population of Boran was about 300,000 in the 1980s and has reportedly increased to over 500,000 in the early 21st century.

Table 13. Mean values of some chemical properties of soils as affected by different land use types.

Land use type†	pH (H ₂ O)	*EC (dS m ⁻¹)	OM (%)	AvP (ppm)
Grasslands	6.40ab	0.07a	3.44c	0.78
Bushed-grasslands	6.40ab	0.08a	2.16b	2.37
Bushlands	5.70a	0.08a	1.36a	0.66
Croplands	7.00b	0.17b	2.85bc	13.85
LSD (0.05)	1.13	0.08	0.79	16.40
SEM (+)	0.46	0.03	0.32	6.70

†Means within a column followed by the same letter are not significantly different at $P = 0.05$. *EC = Electrical conductivity; OM = Organic matter; AvP = Available (Olsen) P; ppm = Parts per million; LSD = Least significant difference; SEM = Standard error of the mean.

More people mean more livestock, more grazing pressure, and a downward spiral in resource condition.

Table 12 illustrates physical features of soils in the study area. In general, these data illustrate how the bushed-grasslands and bushlands differ from grasslands and croplands. Although not statistically significant, the trends for soil texture indicated that both bushed sites tended to be sandier with less silt and clay. The bushed sites had significantly higher values for bulk density and soil compaction compared to that for grassland and cropland sites. The over all trend of bulk density and soil compaction is in the order of bushlands > bushed grasslands > croplands > grasslands.

Table 13 illustrates chemical features of soils in the study area. The loss of soil organic matter (OM) in bushlands and bushed-grasslands is notable.

Considering the grasslands as a reference point, the bushlands, bushed-grasslands, and croplands have lost 61%, 30% and 17%, respectively, of their soil OM content. Croplands were higher in phosphorus and electrical conductivity, which likely reflects their role as drainage sites. Croplands are often in the proximity to livestock holding areas laden with manure. Higher phosphorus levels in cropland soils are most likely due to run-off that transports nutrients from corrals to the fields. It is

very unlikely that the Borana use any commercial fertilizers.

The soil physical data indicate that the bushed sites are degraded compared to the grassland and cropland sites. If it is assumed that bushland and bushed-grassland sites were once grassland sites, the texture trends indicate that enhanced soil erosion has probably occurred with the increased prevalence of woody species. Woody species often out-compete herbaceous species for light and water and result in an under-story devoid of herbaceous vegetation. Sandy textures are heavier and would prevail in bushland and bushed-grassland sites as silt and clay is lost via erosion processes. Exposure of topsoil to rain and trampling by livestock can also lead to changes in bulk density and soil compaction as observed in the data. Compaction of soil surface produces crust, which severely hampers water infiltration and seedling emergence. Increasing bulk density due to compaction results in decreasing total porosity. This leads to a reduction in soil water conductivity in drier soils.

The soil chemical data also indicate that the bushed sites are degraded compared to the grassland and cropland sites. A key indicator is the decline in soil OM. The loss of herbaceous biomass for nutrient recycling and loss of nutrient-rich topsoil via erosion are probably the main contributing factors to changes in OM content.

The changes in land use/land cover for Yabello District are striking and support the theory that grazing lands are decreasing on the Borana Plateau.

However, care must be taken in extrapolating the data too broadly in the region. Annual precipitation in Yabello District tends to be at the high end (>650 mm per year) of records for the Borana Plateau, and this is largely because Yabello District sits at higher elevations. This may predispose Yabello District to more woody encroachment and cultivation compared to other districts of Borana Zone. These results also indicate that the changes in land use and land cover are associated with fundamental changes in soil physical and chemical properties. The losses in soil OM and increases in soil compaction illustrate how difficult it could be to restore rangeland conditions, even with renewal of prescribed burning regimes. The fundamental problems of heavy stocking would have to be corrected as well, in order to improve herbaceous cover, and hence the physical and chemical properties of top soils. An appropriate land-use policy is the first step in a process that promotes sustainable use of ecological resources. Proper stocking rates should be maintained by increasing the off-take of livestock in the Borana rangelands to reduce prospects for further rangeland degradation. There should be also proper management of the grazing lands through some form of rotational grazing systems. Most of the degraded sites of the rangelands should be reclaimed and restored through biological conservation methods of the indigenous grass species.

Activity 8: Jim Ellis Mentorship Program for Graduate Students

Problem Statement and Approach. The PARIMA project has had two recipients of a Jim Ellis Mentorship award. They are both in the final stages of their research. Mr. Mark Mutinda of the Department of Natural Resources at Egerton University in Kenya won a Jim Ellis award for 2004. His dissertation topic deals with risks to key resources in Baringo District, Kenya. Mr. Dejene Debsu Negassa, attending the Department of Anthropology at the University of Kentucky, won an award in 2005. His dissertation



Example of a very degraded range site in Baringo District, Kenya. Photo by Mark Mutinda.

Table 14. Key resources at risk, their descriptions, and ranked vulnerability to loss by pastoral and agro-pastoral communities in Baringo District.

KEY RESOURCE	DESCRIPTION ¹	OVERALL RANKING ON VULNERABILITY TO LOSS		
		Pastoral (n=70)	Agro-pastoral (n=66)	Overall District (n=136)
Grazing Land	Primarily dry-season grazing	1	3	2
Water	Includes all types of watering points	2	1	1
Arable Land	Includes crop lands and valuable trees	4	2	3
Livestock	Includes cattle, sheep and goats	3	4	4

¹Where: Grazing land consists of riverine vegetation used as dry-season grazing, vegetation on hills reserved for dry-season grazing, grazing areas in swamps, depressions and valley bottoms used in dry seasons, and pastures found on high elevations; Water includes permanent springs, rivers, reservoirs, boreholes, and shallow wells; Arable land includes all forms of rain-fed and irrigated lands; riverine trees used as forage for bees and sites to hang hives. The top rank is (1) in all cases. Source: Mutinda (unpublished data).

topic deals with land tenure and social conflict among Guji agro-pastoralists in southern Ethiopia. The Mutinda study has combined GIS with focus group and key informant interviews, as described previously in the *Annual Report 2005*. The Negassa study has involved review of historical literature and key informant interviews.

Progress. The past year has been a period of data analysis for both studies. In the coming year both Mark Mutinda and Dejene Debsu Negassa will finalize their dissertations. Both students have submitted summaries of their work as reported below as Research Briefs. The supervisor for Mutinda has been Prof. A.A. Aboud. The supervisor for Negassa has been Dr. Peter Little.

Dependency Syndrome among Baringo Herders? Evidence from Community Perceptions Concerning Key Ecological Resources. Key ecological resources in arid lands are often characterized by small patches of seasonal grazing and important water points that lend critical support to entire production systems. When key resources are degraded or lost, production systems can be badly compromised. Baringo District of north-central Kenya has endured decades of abuse of natural resources, with causal factors including high rates of population growth and frequent droughts. Coupled with historical breakdowns of the traditional systems of resource management and conservation, resource degradation has accelerated in recent decades,

resulting in poverty and vulnerability for many residents. Parts of Baringo District have been turned into barren wastelands. In response to this situation, government and non-government organizations have repeatedly provided food to Baringo residents through emergency famine relief and food-for-work programs. Some observers note that this pervasive assistance has resulted in many Baringo residents becoming dependent on aid. This has been referred to as a “dependency syndrome.” The rates of failure of local development projects is reportedly high (Aboud, personal observation) and it is tempting to link high rates of failure with the dependency syndrome. Many communities seemingly expect to be spoon-fed by development projects, and do not appear to put much effort to help themselves (Aboud, personal observation).

The main objective of work reported here was to identify, map, and rank vulnerable key resources in seven administrative divisions of Baringo District and engage communities at various levels to understand why key resources have become vulnerable and what interventions could improve the situation. One hundred and thirty six key informants were interviewed from the seven divisions. Four of the divisions were from the arid pastoral zones, while three were from the semi-arid agro-pastoral zones. Key informants were asked to (1) identify the vulnerable and lost key resources in the district; (2) rank the resources in order of their degree of

Table 15. Major factors perceived to influence the vulnerability of key resources as identified by survey respondents (n=136).

KEY RESOURCE	FACTORS IDENTIFIED BY KEY INFORMANTS AS INFLUENCING THE VULNERABILITY AND LOSS OF KEY ECOLOGICAL RESOURCES	PERCENT OF RESPONDENTS
GRAZING		
	Climatic factors (drought, low rainfall, high temperatures)	96
	General insecurity	56
	Expansion of crop cultivation	45
	Lack of grazing guards to control reserved grazing	26
	Invasion by unpalatable bush species (<i>Dodonea viscosa</i>)	19
	Encroachment by settlements (sedentarization)	13
	Invasion by <i>Prosopis juliflora</i> (especially in swamps)	13
	Increased livestock numbers	6
	Breakdown of traditional resource management systems	4
WATER		
	Drying up and silting of earthen dams or pans	98
	Climatic factors (drought, low rainfall, high temperatures)	96
	Insufficient water sources	66
	Animals drinking from sources for people (reservoirs)	55
	Destruction of watersheds	51
	Damage to water points	47
	River changing course	22
	Pollution in up-river catchments	19
	Over subscription of water supplies	14
LAND		
	Population increase	51
	Cutting of riverine vegetation for building materials, charcoal making, and to clear sites for cultivation	32
	Increased soil salinity	22
	Scarcity of land that can be irrigated	19
	Soil erosion	6
LIVESTOCK		
	Diseases and lack of grazing	69

vulnerability; (3) suggest major factors influencing vulnerability and loss of the resources; and (4) suggest possible ways of restoring them. Key resources described by respondents were visited, assessed, and mapped on a GIS template.

Table 14 indicates that pastoralists and agro-pastoralists rank vulnerable key resources differently. Agro-pastoralists tend to have heightened concerns about water and croplands, while pastoralists are most concerned about risk to dry-season grazing and

water. Overall, the most cited resource of concern is water.

Table 15 illustrates the factors perceived to be the main reasons as to why key resources are vulnerable to loss or destruction. These factors can also be aggregated into climate-related causes, direct human-related causes, and other causes. For example, climate-related causes include drought and drying out of the ecosystem, soil salinity (in some cases), as well as changes in the course of waterways.

Direct human-related causes include insecurity, resource competition, over-population of people and animals, destruction of watersheds and riverine sites, pollution, and soil erosion. Other causes, which may be at least indirectly related to human use patterns, include invasion by noxious woody species. Considering factors in these aggregate classes, climate was mentioned 334 times as a factor in the loss of grazing, water, and arable lands, direct human influences were mentioned 510 times as a factor, and “other” was mentioned 32 times as a factor. This suggests that the population considers climate and human-related effects as at least co-dominant in the decline of key resources in Baringo.

The key informants were then asked to suggest possible opportunities to restore vulnerable or lost resources. By far the most popular solutions were to involve government. This included that government should develop water resources (100% of respondents), provide security (98%), restock herds (94%), control noxious bush species (90%), employ grazing guards (85%), provide food relief (82%) and provide title deeds to farmers (52%). In contrast, very few respondents (2 to 8%) suggested ways of restoration or recovering key resources that involved community involvement.

The downward spiral in the ecological condition and trend of natural resources in Baringo District has been well-documented over the past 50 years. Work described here illustrates that the communities of Baringo are well-informed as to the state of their natural resources. They acknowledge that both climate and human activity are responsible for environmental changes. We have been surprised, however, by the minimal role given to community responsibility or initiative in the restoration of key resources by our informants. It is conceded that government must have a central role in activities like water development, promotion of security, and provision of food relief, but the general impression we have is that these communities exhibit an overwhelming tendency to look outside of themselves for intervention approaches. How this has come to pass is an important and interesting question. While it may simply be a case of respondent bias, we speculate that this pattern may rather be indicative of a dependency syndrome. It is possible that repeated government

mismanagement and intervention in the region has undermined any community spirit of self-help. Further work is needed to reveal what dependency syndrome is, to what extent dependency syndrome has indeed become embedded in the local culture, and what constraints does dependency syndrome impose for community-based development. If dependency syndrome is real, then how to deal with it becomes an important issue. There may be interventions or new forms of delivering participatory processes that could be called into play.

Resource Tenure and Conflict in the Guji Areas of Southern Ethiopia. Political events and instability in Ethiopia have left pastoral areas in the southern part of the country increasingly insecure and their land use systems gradually unsustainable. Three major peasant and pastoralist uprisings have been recorded in the past century alone. The source of these political events was loss of land to northern agricultural settlers, exploitation of pastoralists through high tax assessment and forced labor, and alienation of grazing areas for non-pastoral uses. Localized conflicts in southern Ethiopia during the same period are numerous, but remain greatly under-reported; detailed information on them is thus difficult to find. The most notable recent conflicts have been between the Guji and Borana (1974, 1991, and 2006), the Guji and Gabra (2005), the Guji and Gedeo (1995 and 1998), the Borana and Gerri (1991), the Borana and Somali Degodia (1994), and the Amhara and Wollega Oromo (2000).

The pastoral tenure system in southern Ethiopia also has undergone several changes, including a decline in communal use of natural resources, an increase in private ownership of natural resources, and an increase in state ownership and regulation of important grazing areas. Efforts to address the endemic security problems in the southern pastoral areas must consider resource tenure changes and, consequently, how herders have reorganized their resource use and social relations. Oral histories collected through key informant interviews are used to provide brief accounts of the most important tenure and conflict-related changes in the Guji area.

Historically, the simultaneous occurrence of the great East African famine and disease epidemic

of 1889-92 and the incorporation of the Guji into the expanding Ethiopian empire introduced settled farming in the area. The two occurrences ended the era of the Guji's independent and autonomous indigenous *gada'* governance based on a specialized form of pastoralism. The effects of both episodes were significant in that the famine and epidemic decimated local livestock herds, while political incorporation into the Ethiopian empire introduced a tenancy/share cropping form of tenure. One direct effect of imposition of a landlord/tenancy system of the imperial regime was the Guji's southward migration into territories occupied by the Borana. This migration was conducted in order for the Guji to escape exploitation and land alienation in their homelands.

Unlike in other pastoral areas, dry-season grazing areas in the Guji homelands came gradually under the control of landlords of the empire, who leased these areas to settlers from northern Ethiopia. Guji herders had to pay taxes to graze on the fields of the new landlords. Such a practice fragmented the pasture resources, with the problem reaching its climax during the regime of Haile Selassie. The purpose of controlling grazing land by the landlords was not only to reap economic benefits for the empire, but also to force the Guji into agrarian sharecropping arrangements. A significant number of Guji people adopted agriculture under these pressures, while others continued their pastoral livelihood by expanding southward.

Demographic factors also might have played a role in the southward migration of the Guji into less populated pastoral areas, but its contribution to resource conflicts has to be carefully evaluated. The Gedeo people, whose homeland is north of the Guji area, were also expanding southward during the past century, but their relations with the Guji remained relatively cordial. Therefore, the arguments that population pressure and land scarcity cause conflicts are not sufficient to explain how and why competition for land flares into violent clashes. Instead, the ways in which the imperial system established itself among various groups strongly shaped inter-group relationships.

Relations among different ethnic groups in the southern region were reconfigured by wider regional

socio-economic and political processes. The Guji claim a common ancestry, both real and constructed/invented, with the Borana, the Gedeo, and the Gabra. While Guji, Gabra, and Borana ethnically are branches of the larger Oromo group, the Guji and Gedeo peoples were subject to the same imposed land tenure system (called the *gabbar*²). The Borana, however, remained relatively autonomous because its lands were less suitable to cultivation. The soldier settlers, called *neftegnas*, knew that areas beyond the frontiers of the Guji highlands—specifically the Borana area—could not support the agrarian-based *gabbar* system and, thus, animal taxes were imposed on the Borana.

The relative autonomy enjoyed by the Borana was seen by the Guji as evidence of collaboration by the Borana with the imperial system. Furthermore, the imperial government armed the Borana in an attempt to stop the expansion of the Islamic Somali who, according to the government, were considered a significant security threat. During the brief period of Italian occupation (1936-41), the colonial state armed the Guji and the Gedeo, who then fought against the imperial army alongside the occupation force. All these divisive policies and complex alliances created a major rift between Borana and Guji. This uneasy relationship was further aggravated by the Guji's southward expansion into Borana areas, which resulted in conflict but strengthened Guji ties with Gedeo people.

The Gedeo people created and perpetuated the myth of common ancestry with the Guji, in order to maintain peaceful relations with their powerful neighbor. This myth of common origin might have been used to maintain their settlements in the Guji homelands, and their good relations with them. Despite questions surrounding the ethnic identity of the Gedeo and their relationship to the Guji, the myth served to maintain harmony between the two. In 1995 and 1998, however, this changed and significant conflict occurred between Guji and Gedeo. The current government's policy of regional decentralization based on assumed ethnic boundaries and identities was the reason for the violence as it heightened already existing ethnic tensions in the area. Agitated by regional administrators and politicians, some Gedeo refused to pay regional

state taxes because they considered it unfair, since ethnically they did not belong to their current political unit, the Oromiya Regional State. The Guji, on the other hand, considered this dissent by Gedeo as a disruptive tactic that could jeopardize territorial unity and peace. Under the current political system the Gedeo living in Guji area have sought political autonomy, disregarding earlier claims that allowed them access to Guji resources. This redefinition of identities and practices around land and resources was the root cause of the conflict between the two groups.

The recent administrative and boundary changes in the Guji and Borana areas also exaggerated local tensions that eventually (by 2006) led to large-scale conflict. The Borana perceived the recent re-zoning³ as a further infringement on their territories. They have witnessed how government-sponsored boundary referendums result in land losses and other hardships. For example, when the government tried to resolve a territorial dispute between Somali of the Somalia Regional State and Borana by calling for a referendum, the latter group lost permanent control of key wet-season grazing areas. While reciprocal use of resources previously existed between these groups, the current boundary demarcations disrupted this pattern and sharpened cultural identities and differences between the groups. In addition, the political marginalization of customary resource and conflict management institutions rendered the groups incapable of resolving these recent conflicts.

Overall government neglect of customary institutions and practices complicated the processes of conflict reconciliation. Thus, Guji and Borana groups rejected a government proposal for restitution of livestock herds following the 1991-2 conflict that resulted in considerable herd thefts. Rather than return stolen animals after conflicts, they pursue *araara* (peacemaking) through customary procedures. During a recent conflict between the Guji and the Gabra in 2005, however, the restitution of herd losses was enforced by the government. Ad hoc committees were established from both groups to return stolen animals and this made reconciliation especially difficult. In addition, the Guji accused the Gabra, who increasingly have adopted Islam, of killing women and children during the conflict, a

major violation of customary rules of engagement, while the latter accused Guji of using excessive force. After more than one year tension has not subsided and the Gabra's recent demand for political autonomy has only aggravated the problem.

Disputes within groups are also common, and reflect changed socio-economic and political conditions in the region. In the past a common herd management strategy among the Guji was the seasonal movement of herds between lowland and highland areas. If drought occurs in the lowland areas, which often is the case, pastoralists migrate to the cool, forested highlands, where their livestock feed on tree leaves and crop stalks. Similarly, those highlanders with large numbers of animals migrate to the lowland areas, where there usually are sufficient pastures in wet seasons. The opportunity to move between different geographical landscapes is reaffirmed by a complex set of social relations between residents of the different zones. These social ties are based on kinship (and clanship), marriage, and friendship relations. Other social mechanisms among the Guji are in place to support the pastoral sector. *Dabaree* and *hirba*⁴, for example, play an important role in overcoming pasture shortages and distributing livestock between households and various ecological zones. In addition, people also depend on these institutions to restock their herds after droughts and/or other misfortunes like raiding.

In the past another important herd management strategy among the lowland Guji was the splitting of herds into *foora* (herding camps) and *warra* (homestead area) grazing areas. This strategy was jeopardized after the 1977-8 Ethio-Somali war, when the government forced the Guji to settle as punishment for their involvement in the war. Movement was limited by the peasant association (PA) regulation that required permission to migrate from the former local administration. So, a host community of a neighboring area would not accept a Guji herder and his livestock unless they had been formally released by the administration. Those Guji families who did not want to settle down and farm also were not accepted. Under this constrained policy environment, enclosures and farmlands gradually expanded and the local strategy of splitting herds

into *warra* and *foora* units increasingly became impractical. One significant recent change in the Guji pastoral system has been the transition of *foora*, seasonal camps, into *warra*, base camps, with the expansion of farming into these areas.

The factors that facilitated the permanent settlement of households also increased disputes over exclusive use of lands for farming and grazing. Currently there are three conditions under which individuals may claim ownership to farmlands:

(1) If the land was allocated by any “recognized” institution or individual. During the Derg⁵, there was a development committee, *limaatii*, which was mandated with the responsibility of allocating land for farming. After farmland was awarded individuals would make enclosures around their farmlands for exclusive use by their herds, resulting in a kind of spontaneous privatization of pasturelands (*kaloo*);

(2) If people just cleared fields for cultivation, they could make exclusive claims based on usufruct rights. Thus, continuous use of lands for cultivation could entitle individuals to ownership claims. During the Derg, a farmer that was absent from an area for more than two years lost claim to his/her farm. However, to avoid loss of those rights, farmers used to entrust the land to clansmen or in-laws in the presence of local elders and neighbors so as to locally confirm the transaction. This, to some extent, ensured mobility as well as ownership of their farmlands at the same time. Under the current government (post-Derg), the land is given to other applicants if the owner is absent from the local area for two consecutive years, even when it is entrusted to relatives; or

(3) If people have farmland allocated to them by elders.

Lands can be obtained under any of the above conditions, but claims can become contentious if a farmer makes a counter claim or if the occupant tries to cut-off herding routes across the farmstead. Elders try to maintain both customary institutions and the communal system, but they are caught in a paradox, both as upholders of the custom and private owners of *kaloo*, grazing lands, and farmlands for their own use. These processes, far from maintaining the customary institution and common property relations, actually facilitate their decline.

From the foregoing discussion it is clear that the imposition of state administration undermined customary institutions, including conflict resolution mechanisms, and made reconciliation very difficult. Dealing with ethnic and/or resource-based conflicts requires building effective institutional arrangements and strengthening those indigenous institutions that regulate and allocate scarce rangeland resources in pastoral and agro-pastoral areas. Thus, the following approaches to conflict management are recommended:

(1) Groups sharing similar cultural values, such as the *gada* institution, can rely on their established system of conflict management to reduce conflicts with limited external support;

(2) For groups that do not have an established and shared system of conflict management, NGOs can play a brokering role to bring the parties together to solve their problems; and

(3) Customary authority has to be recognized and strengthened by delegating power back to the people in order to control the expansion of farming, exclusive land use of rangelands, and the blocking of herding routes in cultivated areas. All of these are common causes of conflict within communities.

The feasibility of these recommendations depends on the commitment of the government to create an enabling environment for local conflict resolution. The administration can help to do this by recognizing that customary institutions can be complementary, instead of competitive with formal state institutions.

GENDER

Gender dimensions of our project are reflected in terms of: (1) Team organization; (2) research issues being pursued; (3) training; and (4) aspects of outreach emphasis. For example, we have one economist on our core team with significant experience working on WID (Women In Development) issues in agricultural production systems and who has published in this area. We also have an anthropologist, other economists, and even an ecologist with extensive background collecting and analyzing sex-disaggregated data on pastoral

household production systems. They have all published on topics related to the differential impact of risk management strategies on men and women. We have employed several female enumerators for research and women also serve our outreach activities in southern Ethiopia as teachers in a non-formal education program and as mentors in cross-border, community risk-management activities. Several women represent our national partner institutions, prominently including agencies in the Ethiopian regional state of Oromia.

We have carried out a range of surveys in which data are collected from both men and women among both pastoral communities and among female-headed households in settled communities to describe and identify the influence of gender on household risk-management strategies (see Research Activities 1 and 2 above). Previous research has shown that the separate domains of men's and women's decision-making about income-generating strategies can be at odds in ways that may be exacerbated by development interventions targeting one production strategy over another. The research results being produced can be used by USAID to better identify and address gender inequalities.

Finally, in studying the area we have determined that females are under-represented in terms of relative access to formal education and exposure to micro-enterprise concepts. We are seeking to redress these issues through Research Activity 5 whereby females continue to be a focal point for recruitment in short-courses, workshops, and informal education programs. These activities are supported by the USAID Mission to Ethiopia, but researchers are monitoring activities and documenting impacts of training and outreach.

POLICY

Our main goal regarding policy is to have a positive influence on decisions that affect pastoral peoples in Kenya and Ethiopia. We want to achieve this goal primarily through engagement and education of decision makers. We have developed an extensive network for distribution of PARIMA Research Briefs and the PARIMA UPDATE newsletter (see Research

Activity 4 above). We will continue to invite decision makers to attend meetings, workshops, field tours, and training opportunities. We have also used the PARIMA Research Briefs to give policy makers a forum to express their observations and views (see Research Activity 6 above).

OUTREACH

The Outreach Unit of the PARIMA project has been previously introduced in the GL-CRSP Annual Report for 2000. Outreach funding has been provided from the USAID Mission to Ethiopia. Current outreach activities have been previously mentioned under Research Activity 5. The objectives of PARIMA Outreach are to build awareness and capacity of front-line development personnel and pastoral communities to better understand the utility of risk-management interventions and identify best-bet approaches to improve pastoral risk management based on results from pilot interventions and associated research.

DEVELOPMENTAL IMPACT

Perspectives on development impact are similar to those voiced in previous GL-CRSP Annual Reports. These are summarized as follows.

Environmental impact and relevance. The benefits of our project to the environment tend to be indirect rather than direct, and medium- and longer-term rather than short-term. Our basic position is that improved risk management will mitigate asset loss and poverty among pastoralists and agro-pastoralists. When poverty is mitigated, risk to the environment will lessen. For example, one tenet of our approach is that pastoralists need to make more pre-emptive moves to mitigate crisis induced by drought and growing human populations. One tactic is to sell some animals before a crisis occurs, and use the funds received as household-level savings and community investments. The success of this depends on well-functioning markets, credit union formation, education, etc. The idea is that if such a tactic can be successfully used across a society, the rate

of growth in stocking rates would be mitigated. This would reduce the specter of heavy stocking rates on the land during years of lower-than-average rainfall, which is the key window when range vegetation can be degraded. The “boom and bust” in the cattle cycle would also be dampened as a result. The build up in non-livestock capital and investment would then permit societies to diversify their economies. This diversification could spur growth of urban job opportunities and mitigate the incidence of poverty among pastoral and agro-pastoral households. Mitigating poverty would then reduce the specter of poor people being engaged in destructive activities such as charcoal making, harvesting of green fuel wood, and opportunistic cultivation.

Agricultural sustainability. A sustainable agriculture is one where interventions are: (1) beneficial—or at least neutral—for the environment; (2) socially acceptable; and (3) economically profitable. The premise behind our project is that, left to their own devices, traditional pastoral or agro-pastoral production systems in our study region are unsustainable. For example, there is a loss of land to population growth and environmental degradation. There is an unraveling of the traditional social order in some cases, which can often be traced to competition for limited resources. There is abundant evidence that whether due to poor demand, bad infrastructure, and/or inadequate marketing strategies of producers, pastoralism in the region is typically unprofitable. Evidence of un-sustainability includes things like the chronic need to feed tens of thousands of people in the region each year, the re-location of poor households nearer to towns and settlements where they engage themselves in petty trade to stay alive, and the increasing poverty and declining living standards of pastoralists in general. By coming up with risk management tools, which in part should allow pastoralists and agro-pastoralists to save and invest outside of their traditional sphere, the resulting investment surge for education and entrepreneurial activity in towns and settlements should primarily lead to growth of local economies with benefits for the environment, social order, and pastoral economy. As outlined immediately above, our risk management interventions range from neutral to positive for the environment, and this conforms to the first criterion

of sustainable agriculture. Accumulation of wealth and efforts to mitigate social conflicts should allow the social fabric to heal—poverty is bad for the maintenance of traditional cultures. This fits the second criterion. The third criterion is dealt with by several economic outcomes that vary in terms of the relevant time scale. Short-term benefits would include an expansion of local markets for pastoral products. Longer-term benefits would include allowing more pastoralists to emigrate out of the traditional sector due economic diversification and increased employment opportunities in towns and settlements. Facilitation of emigration is the ultimate humanitarian solution to the risk-management dilemma for pastoralists. This is because population growth reduces resources per capita and therefore increases vulnerability of populations to endogenous and exogenous shocks.

Biotechnology. The PARIMA project does not have a component dealing with biotechnology.

Contributions to United States agriculture.

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

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

Contributions to host countries. Contributions to our host countries will mostly be felt through our outreach activities (described above) and training of host-country nationals. Outreach will primarily have impact on project beneficiaries—pastoralists and agro-pastoralists—but it will also have impact on development professionals and their organizations that link to us directly. In the training sphere our past contributions have also included computers, books, sponsorship for people to attend international conferences and other technical support for our main academic partner in Kenya, Egerton University. A

broadening of our collaborative research role will benefit KARI-Marsabit (Kenya) and OARI-Yabelo (Ethiopia).

Linkages and networking. This has been previously covered in our section on Outreach.

Collaboration with IARCs and other CRSPs. We collaborate with the International Livestock Research Institute (ILRI) in both Ethiopia and Kenya. We typically hold our workshops at ILRI conference facilities. Some administrative and logistical support is provided to us by ILRI. We have strengthened ties to the ILRI Crisis Mitigation Office (CMO) headed by Dr. Jean Ndikumana at ILRI-Kenya. We have also more recently linked to Dr. Patti Kristjanson also of ILRI-Kenya. The other CRSP we have connected to in the past is the BASIS CRSP. Drs. Peter Little and Christopher Barrett, American PIs on the GL-CRSP, and Prof. Abdillahi Aboud, regional PI on the GL-CRSP, used to be participants on the BASIS CRSP. The GL-CRSP and BASIS CRSP shared an interest in policy and economic issues that deal with cross-border relations.

OTHER CONTRIBUTIONS

Support for free markets and broad-based economic growth. Interventions that will be advocated by our project will be in direct support of free markets and economic growth. Some of this has been previously described. This prominently involves linkages between markets and formation of benefits-oriented cooperatives to empower pastoralists at the local level. At our biennial workshop in Njoro (2001), some presentations dealt with outreach ideas to assist pastoralists to form their own cooperative associations to spur development processes—the idea being that a local association could form and pool capital resources to first organize a community savings and credit association. This would be an impetus for the group to procure production inputs and invest to improve their marketing capability to make themselves less vulnerable to trading bottlenecks. A group, for example, could purchase a large truck and independently handle livestock shipping. The outreach entity would only provide the initial training and a few select inputs to get it rolling. The success of such an endeavor

would rely heavily on the availability of livestock and grain markets and their efficiency of operation. Our initiatives in livestock marketing research, and attempting to forge a partnership with private sector livestock exporters also are key elements indicating our awareness of the importance of commerce and the private sector. Taken together, these areas of emphasis reflect the functioning of free markets, a role for agribusiness, and developing a capability for pastoralists to empower themselves.

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

Concern for individuals. Our project incorporates a concern for individuals in several ways. One is through technical and advanced training opportunities, with a focus on host-country nationals at the master's and doctoral levels. Other evidence is provided by how we have organized our applied research and outreach. For research, we realize that improved risk management will ultimately occur at the level of the individual. For outreach, priorities like public education, conflict mitigation, and formation of benefits-oriented cooperatives are a testimony to the value we place on helping individuals improve their lives by being able to deal with risk by making more informed choices.

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

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

LEVERAGED FUNDS AND LINKED PROJECTS

The value of leveraged funding for PARIMA during 2005 was \$605,322. The sources of those funds are as follows:

USAID Ethiopia Mission (GL-CRSP 103-20-27 Mod 27-ETH09), outreach, action research, and non-degree training, 10/1/05-9/30/06, \$183,350.

Cornell University, general graduate student support, 10/1/05-9/30/06, \$209,923.

World Bank, graduate student support for V. Hoffmann, 10/1/05-9/30/06, \$17,600.

World Bank, research support for Kenya, 10/1/05-9/30/06, \$10,000.

Portugeuse Foundation, graduate student support for P. Santos, 10/1/05-9/30/06, \$41,754.

Syracuse University, publication support, 10/1/05-9/30/06, \$1,291.

University of Kentucky, international travel support, 10/1/05-9/30/06, \$1,600.

University of Kentucky, graduate student support for D. Debsu, 10/1/05-9/30/06, \$18,000.

Social Science Research Council, graduate student support for K. Greenough, 10/1/05-9/30/06, \$15,000.

National Science Foundation, graduate student support for K. Greenough, 10/1/05-9/30/06, \$12,000.

National Science Foundation, graduate student support for D. Debsu, 10/1/05-9/30/06, \$12,000.

Egerton University, general in-kind support (faculty, staff, services, stipends), 10/1/05-9/30/06, \$39,864.

USAID Ethiopia Mission (CARE Pastoral Livelihoods), outreach, action research, and local non-degree training, 10/1/05-9/30/06, \$30,000.

Kenya Agricultural Research Institute (Marsabit), general support for non-degree training, 10/1/05-9/30/06, \$1,570.

Oromia Agricultural Research Institute (Yabelo), general support for non-degree training, 10/1/05-9/30/06, \$8,920.

International Livestock Research Institute, non-degree training, 10/1/05-9/30/06, \$450.

Community Initiatives Facilitation Assistance,

workshop support (senior attachment program), 10/1/05-9/30/06, \$2,000.

TRAINING

Degree Training

Bellemare, Marc. Cornell University, M, Economics, PhD.

Green, Alan. Cornell University, M, Economics, PhD.

Greenough, Karen. University of Kentucky, F, Anthropology, PhD.

Haile, Getachew. Alemaya University (Ethiopia), M, Range Management, MSc.

Hoffman, Vivian. Cornell University, F, Economics, PhD.

Jillo, Abdulahi. Egerton University (Kenya), M, Human Ecology, PhD.

McGeehan, Keri. Cornell University, F, International Development, MPS.

Mesele, Sintayehu. Alemaya University (Ethiopia), M, Range Management, MSc.

Michelsen, Hope. Cornell University, F, Economics, PhD.

Mude, Andrew. Cornell University, M, Economics, PhD.

Murphy, Daniel. University of Kentucky, M, Anthropology, PhD.

Mutinda, Mark. Egerton University (Kenya), M, Human Ecology, PhD.

Naschold, Felix. Cornell University, M, Economics, PhD.

Negassa, Dejene. University of Kentucky, M, Anthropology, PhD.

Olekaikai, Nicholas. Egerton University (Kenya), M, Human Ecology, MSc.

Santos, Paulo. Cornell University, M, Economics, PhD.

Yirbecho, Amare. Cornell University, M, Natural Resources, PhD.

Non-Degree Training

Policy research conference on Pastoralism and Poverty Reduction in East Africa, June 27-

28, 2006 in Nairobi, Kenya. Facilitated by Patti Kristjanson, Chris Barrett, John McPeak, and Peter Little. To review recent research and identify policy implications. Attended by 122 participants (87 male and 35 female).

Conference on the Sustainable Development of Pastoral cooperatives in Ethiopia, September 29-30, 2006 in Adama, Ethiopia. Facilitated by Solomon Desta, Getachew Gebru, Dadi Amosha, and Mekonen Bekele. To review research and outreach results, and inform policy and best practices for cooperative development. Attended by 41 participants (32 male and 9 female).

Third Pastoral Producers Tour to Export Facilities and Highlands Cooperatives, March 27-April 3, 2006 in the Central Ethiopian Highlands. Facilitated by Dadi Amosha, Solomon Desta, and Getachew Gebru. To educate pastoralists on livestock export marketing chain. Attended by 17 participants (5 male and 12 female).

Fourth Small-Scale Business Development Training for Illiterates, August 15-19, 2006 in Yabelo, Ethiopia. Facilitated by Dadi Amosha, Debebe Teferra, Beyene Bekele, and Kebede Assefa. To train pastoralists in principles of small business management. Attended by 33 participants (6 male and 27 female).

OARI Research Priority Setting Meeting, August 13-15, 2006 in Yabelo, Ethiopia. Facilitated by Lemma Gizachew and Getachew Gebru. Stakeholder meeting involving researchers, pastoralists, development agents, and policy makers to set research agenda for new research center. Attended by 49 participants (48 male and 1 female).

Sixth Cross-Border Steering Committee Meeting for Kenya and Ethiopia, Feb 23-26, 2006 in Moyale, Kenya. Facilitated by Seyoum Tezera and Chachu Tadecha. To set priorities for cross-border problem solving and agenda for future general meeting. Attended by 30 participants (30 male).

Diploma in Development Leadership study tour, July 2006-December 2006 in Halifax, Nova Scotia (Canada). Facilitated by the Coady Institute (St. Francis Xavier University). To train student candidate in development studies. Attended by 1 participant (1 male).

OARI Research Methods Shortcourse training,

May 10-13, 2006 in Addis Ababa, Ethiopia. Facilitated by Gemechew Defega, Getachew Gebru, and Solomon Desta. To review applied social science field methods and database management skills. Attended by 18 participants (16 male and 2 female).

KARI Research Methods Shortcourse training, March 7-10, 2006 in Marsabit, Kenya. Facilitated by J.N. Mwangi, S.B. Wepukhulu, and Victor Waireri. To review applied social science field methods and database management skills. Attended by 16 participants (13 male and 3 female).

Senior field attachment for university seniors, October 2005-May 2006 at the Borana Plateau in Ethiopia. Facilitated by Getachew Gebru. To provide hands-on field research experience for undergraduates from Ethiopian universities. Attended by 2 participants (2 male).

OARI/KARI Cross-Border Collaborate Research Meeting, February 22-26, 2006 in Yabelo, Ethiopia. Facilitated by George Keya, Getachew Gebru, and Lemma Gizachew. To plan cross-border collaborative research. Attended by 12 participants (11 male and 1 female).

Training in Principles of Cooperative Development course, 2005-2006 in Southern Ethiopia. Facilitated by District Cooperative Staff, District Pastoral Development Staff, and PARIMA Staff. To train pastoralists in concepts and procedures concerning cooperative development. Attended by 210 participants (210 female).

Rural Savings and Credit Training for Illiterates, several courses from 2005-2006 at the Borana Plateau in Southern Ethiopia. Facilitated by District Cooperative Staff, District Pastoral Development Staff, and PARIMA Staff. To train pastoral members of cooperatives in the principles of savings and credit. Attended by 676 participants (47 male and 629 female).

Experience Sharing and Performance Assessments Among Collective Action Groups meetings, December 5-16, 2006 at the Borana Plateau in Southern Ethiopia. To self-evaluate and exchange the best practices among savings and credit groups and cooperatives. Attended by 984 participants (231 male and 753 female).

COLLABORATING PERSONNEL

Ethiopia

Gebru, Getachew. Utah State University, Animal Science, PhD, Post-doctoral
Gizachew, Lemma. Oromia Agric. Research Inst., PhD, Animal Science, Research Leader
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Jabbar, Mohammed. International Livestock Res. Inst, PhD, Economics, Research Leader

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Aboud, Abdillahi. Egerton University, Human Ecology, PhD, Professor
Desta, Solomon. Utah State University, Economics, PhD, Post-doctoral
Keya, George. Kenya Agric. Research Inst., Range Science. PhD, Center Director
Mahmoud, Hussein. Egerton University, Anthropology/Geography, PhD, Lecturer

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Barrett, Chris. Cornell University, Economics, PhD, Professor
Coppock, Layne. Utah State University, Range Science, PhD, Assoc. Professor
Doss, Cheryl. Yale University, Economics, PhD, Faculty
Little, Peter. University of Kentucky, Anthropology, PhD, Professor
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Resource Conflict Institute (RECONCILE)
P.O. Box 7150
Nakuru
Telephone: 254-37-44940
Fax: 254-37-212865.

PUBLICATIONS

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the Complex Role of Social Capital in Transitioning Rural Economies. PhD Dissertation. Dept. of Applied Economics & Management, Cornell University.

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ABSTRACTS AND PRESENTATIONS

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Aboud, A.A., M. Odhiambo, and D. L. Coppock (2006). Poverty reduction strategy paper (PRSP): A roundtable discussion. Presentation made at Pastoralism and Poverty Reduction in East Africa: A Policy Research Conference. Held 27-28 June at the Safari Park Hotel, Nairobi, Kenya. Organized by the International Livestock Research Institute (ILRI).

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FOOTNOTES

¹According to Legesse (1973:81), the term gada cannot be given a singular interpretation. It stands for several related ideas. “It is first of all, the concept standing for the whole way of life”.

²Gabbar, as it was applied to the Guji area, goes beyond just ownership/usufruct right on land where settlers collected tax; they also commanded tenants’ labor.

³Borana zone was split into Guji and Borana in 2003 and again it was proposed to split the Guji zone into two—East and West Guji Zones—with four woredas from the Borana zone included.

⁴Dabaree is a transfer of livestock to a daughter by her parents after marriage for use of their labor and milk during the girls’ life time and returned back at her death, while hirba is a contribution received from clan members during bad times.

⁵Derg is the military regime that ruled Ethiopia from 1974-1991.

**LIVESTOCK INFORMATION NETWORK AND KNOWLEDGE SYSTEM (LINKS) FOR
ENHANCED PASTORAL LIVELIHOODS IN EAST AFRICA**

NARRATIVE SUMMARY

The urgency to address the needs of pastoral communities in Eastern Africa has risen dramatically in the past few years, prompting national governments, non-governmental organizations (NGOs), and international donors to explore high impact interventions for these neglected people. Given the high dependency of pastoral family livelihood on cash income from the sale of livestock and livestock products, institutional focus has been directed toward improving livestock market information, infrastructure and efficiency. A reliable market information system creates transparency and a basis for the pastoralists to make marketing decisions. An extensive review of the wide array of livestock market development activities in Eastern Africa has revealed a lack of viable livestock market information systems to support decision-making of traders, pastoralists and policy makers. Using a partnership approach with existing livestock marketing institutions in Ethiopia, Kenya, and Tanzania, LINKS has designed and is delivering an equitable livestock information and communication system that provides monitoring and analysis technology to foster strategic partnerships between pastoral communities, markets and policy. The LINKS program has established the necessary technical framework for reporting of prices and volumes and helped establish a limited number of monitoring markets. This past year focused on building viable market information flow, stakeholder training and institutional strengthening for adopting LINKS in Kenya, Ethiopia, and Tanzania. The LINKS project completed a spatial model of pastoral livestock movement in response to forage supply, terrain, water supply and ethnicity. There will be a focus on incorporating the reporting of disease, market prices and conflict in the model in the

coming year. With the framework established it will be possible to set the foundation to better understand the impact of the LINKS project on market efficiency to determine if marketing efficiency is improved and whether pastoralists are gaining a greater share of terminal market prices when they sell their animals. Impact of the LINKS technology package on agency effectiveness in information collection and dissemination on pastoral decision-making will also be assessed.

RESEARCH

Core Activity: Design and Deploy LINKS in East Africa

The Global Livestock Collaborative Research Support Program (GL CRSP) through the Livestock Early Warning System (LEWS) and LINKS projects has infused two valuable tools into the Eastern Africa region that, 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. Thus, if the right institutions

and mechanisms are put in place, most drought-associated disasters that are currently facing many of the East African communities could be mitigated, providing communities with sustainable means of meeting their demands for food and other necessities of life so that they can be part of the global vision of achieving the Millennium Development Goals.

Problem Statement and Approach: The primary activities focused on refining the design and field testing of a unified approach to developing and deploying a livestock marketing information system (LMIS) within the framework of markets in Kenya, Ethiopia and Tanzania. Our specific objective was to design and deploy new communication and information technology to create a livestock information system to support decision making at multiple scales from policy makers to pastoral communities within livestock market chains of Eastern Africa. The core program involved a series of simultaneous activities focused on information technology development, establishing communications infrastructure and technology, identifying and developing working relationships and skills with key livestock marketing authorities/divisions/agencies and livestock trade organizations in Ethiopia, Kenya, and Tanzania, acquiring livestock market information to support the need for market information and modeling analysis, as well as the design of potential output products and delivery systems. Dr. Abdi Jama was assigned as primary liaison between LINKS/TAMU and the Ethiopia marketshed. Dr. Robert Kaitho was assigned as primary liaison between LINKS/TAMU, and the Kenya and Tanzania marketsheds. Our three in-country program officers Mr. Abdirahman Ali based in Addis Abba, Ethiopia, Mr. Gatarwa Kariuki in Nairobi, Kenya and Ms. Margaret Kingamkono in Arusha, Tanzania provided liaison with key ministries, NGOs and pastoral communities in each country. Mr. Joseph Ndung'u joined the LINKS project in Nairobi, Kenya in January 2006 as a consultant to assist in the integration of LEWS forage products with LINKS livestock market information. Specifically, he conducted field verification of PHYGROW forage outputs and carried out community level surveys to assess the influence of water stability on livestock migration

in Northern Kenya. Dr. Laban MacOpiyo joined the LINKS project in August 2005 as a Postdoctoral Research Scientist. Dr. MacOpiyo is focusing on the implementation of the USAID Ethiopia Mission funded program on the expansion of LINKS in the Somali and Afar regions in the Pastoralist Livelihoods Initiative (PLI).

Progress. The necessary partnering with Kenya, Ethiopia and Tanzania livestock marketing agencies has been established with agreements to work with the LINKS program to develop an integrated livestock marketing information system established in Ethiopia, Kenya, and Tanzania.

In Kenya, the information communication technologies developed by LINKS have been adopted for developing a national livestock marketing information system (NLMIS). Success of implementation and expansion of the system is based on solid and equitable support provided by the participating partners. These partners include the Livestock Information Network and Knowledge System (LINKS), Ministry of Livestock and Fisheries Development (MoLFD), Kenya Livestock Marketing Council (KLMC), Food and Agriculture Organization (FAO), Arid Lands Resource Management Project (ALRMP), Vétérinaires Sans Frontières (VSF)-Suisse, and Food and Research Management (FARM)-Africa. From only 3 markets the system is now reporting in 13 markets (Figure 1). LINKS supports data collection and reporting in 6 markets while KLMC is supporting the rest. MoLFD provides the main structure and network of market data monitors and supervisors and is charged with the responsibility of administering the system. FAO, in partnership with ALRMP, has made a major contribution towards sensitizing a wide array of stakeholders at the district level by funding workshops that were conducted in 14 districts to create awareness and mobilize stakeholders in the different markets and districts to expand the NLMIS and solicit further support for the expansion and sustainability of the system. They have also supported workshops designed to train market data monitors that were selected at the district workshops and have committed to support workshops to train supervisors and users of the information at market and producer

Figure 1. LINKS livestock markets in East Africa



levels. FARM-Africa, through the Community Animal Health Network (CAHNET), supported a workshop bringing policy makers from the private sector, development agencies, non-governmental organizations, community-based organizations and the public with the aim of creating awareness about the system and exploring opportunities to improve it. The network has also funded the printing of brochures to extend messages relating to the system. LINKS has supported over 7 masters and PhD students mainly to undertake field work in the area of livestock marketing and information.

In Ethiopia, the LINKS leveraged funds through PLI for expanding market coverage and increasing of the 5 livestock markets monitored last year to 9 markets. Training on protocols of livestock market information data collection for

line bureau and partner technical staff has so far reached a critical mass, and over 50 individuals both in Non-governmental and governmental agencies have been trained in the past year alone. Regular dissemination of price/volume livestock market information for most of the markets is now an established and ongoing activity. The following are the new organizations that have vested interest in LINKS reporting formats: Afar, Somali, Tigrai, Amhara, Southern Nations Nationalities and Peoples (SNNP) and Oromiya regions Disaster Prevention and Food Security Bureaus, Afar and Somali Regions Pastoral and Agro-Pastoral Research Institutes, Afar, Somali, Tigrai, Amhara, SNNP and Oromiya Regions Agriculture and Rural Development Coordination Offices, Tigrai Bureau of Agriculture and Rural Development, Oromiya Pastoral Development Commission, Afar and Somali Regions Pastoral and Rural Development coordination

offices, Afar and Somali Regions Agriculture and Livestock Development Bureaus, Tigrai, Amhara, SNNP and Oromiya Regions Agriculture Marketing Agencies and international and local Non-Governmental Organizations working in Ethiopia like ACIDI/VOCA Ethiopia, Save the Children UK, Afar Pastoral Development Association (APDA), Ogaden Welfare Development Association (OWDA). Currently the principal Regional bureaus in which we have new market monitors are; Afar and Somali Regions Agriculture and Livestock Development Bureaus, Afar and Somali regions Disaster Prevention and Food Security Bureaus, Dire Dawa Council Agriculture Bureau and Afar and Somali Regions Pastoral and Agro-Pastoral Research Institutes.

The past year has also seen the completion of the setup of new Livestock Early Warning System

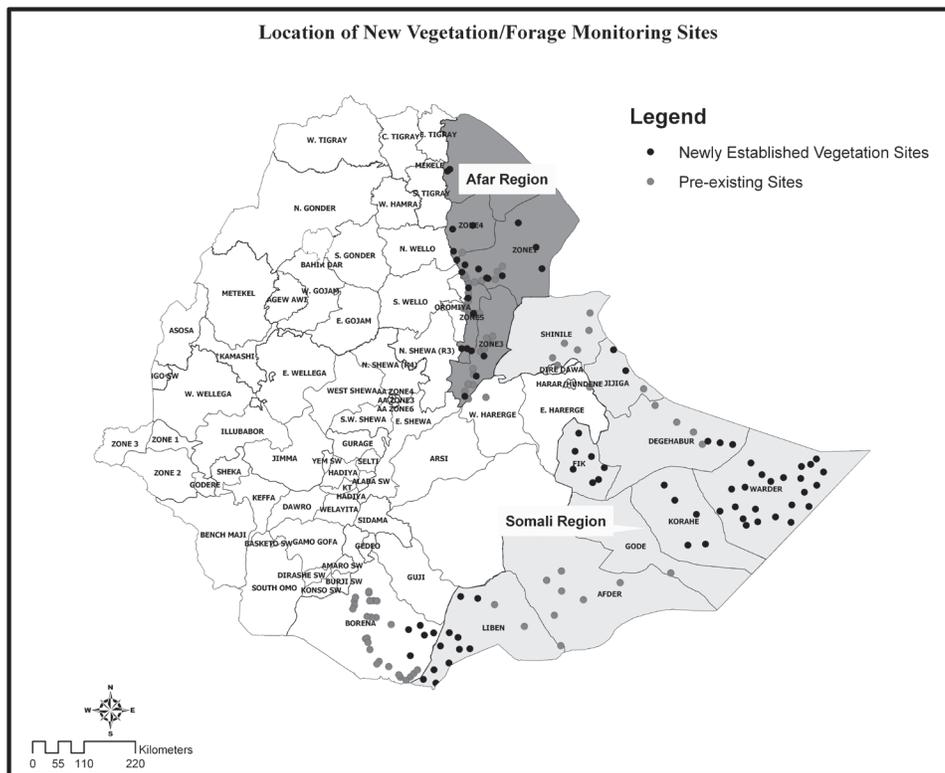
(LEWS) vegetation monitoring locations in Ethiopia. 80 new sites have been established and will be integrated into the LEWS forage early warning system (Figure 2). The specific achievements in the last year include:

- LINKS has been able to build capacity within partner institutions through training of monitors/technical staff and end users (more than 50 individuals) of the livestock market information about data collection and dissemination formats and protocols.
- The project has established necessary partnering with relevant line bureau and other important agencies in the two regions and has established agreements to work with the LINKS program to develop and deliver an integrated livestock marketing information system for both Afar and Somali regions. These include Save the Children UK, Afar and Somali regions Disaster Prevention and Food Security Bureaus, Afar Pastoral Agriculture and Rural Development Bureau, Afar and Somali Regions Pastoral and Agro-

Pastoral Research Institutes, Afar and Somali Regions Rural Development coordination offices and local Non-Governmental Organizations working in both the regions like Afar Pastoral Development Association (APDA) and Ogaden Welfare Development Association (OWDA).

- The LINKS project has secured consensus and systematic adoption of market data collection format by key government bureaus and NGO institutions in Somali and Afar regions. Dire Dawa Council Agriculture and Rural Development Bureau is one of the offices LINKS has institutionalized for the market monitoring activities. The bureau is motivated by the usefulness of the system and has proposed to add two markets in the rural parts of the council that have accessible transport and communication infrastructures. The LINKS project facilitated training of monitors and technically helped the bureau achieve its goal. The construction of the market places with extra rooms that will serve as information dissemination centers are

Figure 2. Location of new LEWS vegetation monitoring sites in Ethiopia



currently underway. LINKS reporting format has achieved national acceptance, though currently functional only in pastoral regions. Highland regions of Amhara, Tigray, Southern Nations and Nationalities People's Regional State and Oromiya are demanding their regions be incorporated into the LINKS system. Some of these regions like Tigray have proactively requested the LINKS office to technically help them establish a regional system that would also feed both grain and livestock market information to the national system.

- The LINKS project carried out an assessment study on the status of Livestock Market Information Systems in the Highlands of Ethiopia.
- The project held a stockholder's workshop with key policy makers and in collaboration with the Texas A&M University's Sanitary and Phytosanitary Standards Livestock Meat Marketing Project (SPS-LMM) in Ethiopia on extension of LINKS LMIS activities to the highlands of Ethiopia.
- LINKS provided the Ministry of Agriculture and Rural Development internet broadband connectivity to the server donated by LINKS. The Server is now just waiting for an IP address to get it up and running with the LINKS database system.
- Using Leveraged funds from the PLI project, LINKS completed a set up of 80 more vegetation monitoring sites in the Afar and Somali regions for the expansion of the forage Livestock Early Warning System (LEWS) analysis and communication system in Ethiopia (Figure 2).
- In collaboration with new partnerships developed with ACIDI/VOCA, LINKS now co-produces and disseminates on a weekly basis livestock market and pastoral forage early warning situation information to users through a weekly livestock market newsletter which is broadcast in the English, Somali and Oromia languages.
- LINKS has reached an agreement with the First Voice International (FVI) - formerly the WorldSpace - project on the format for dissemination and packaging of market and forage information to the rural communities of

Ethiopia through 34 Community Information Centres (CIC) being set up in the Somali region and 5 in the Afar region.

- LINKS has been able to hold extensive discussions and is at an advanced stage with WFP on the prospect of using the LINKS forage early warning products as a basis of Pastoral livelihood risk assessment for contingency and insurance planning in Ethiopia to cover the pastoral regions in Somali, Afar, Oromia, and SNNP Region. The target is to attempt to eliminate the food intervention appeals process in favor of contingency planning and contingency financing achieved through an insurance scheme.
- LINKS has contributed and is collaborating with sister project PARIMA towards the development of a dynamic spatial GIS database for Southern Ethiopia and Northern Kenya.
- LINKS has begun preliminary assessment and fieldwork activities under the NASA-ROSES project (refer leveraged project) in collection of information on water sources (monitorable from space) for the development of a water early warning system to be incorporated into LEWS. The team has so far been able to collect information from 12 relevant water source locations.

In Tanzania, reporting of market prices and volumes from the 5 Markets at Igunga, Dar es Salaam (Pugu), Arusha (Meserani), Moshi (Weruweru) and Shinyanga (Mhunze) continued using SMS text messaging through use of cell phones. Sensitization and awareness creation was emphasized so as to draw the attention of end users of LINKS products to the existence of the information. This was done through participation in an agricultural show, reports, and some consultative meetings.

Efforts were also made to improve linkages at the Ministry level as part of a strategy to institutionalize the system into policy decision making and to gain financial support for its expansion and sustainability. The Ministry of Industries, Trade and Markets, the Ministry of Livestock Development as well as the local government are the main stakeholders of the LINKS in Tanzania.

The GL CRSP LINKS and LEWS were presented to high level policy makers, traders associations and other private sector stakeholders so as to develop the capacity for the integration of the information from the LINKS system as part of the routine decision making process.

There are 5 markets under monitoring for the LINKS system from which market information is collected and stored at the country server in Dar es Salaam. A website for LMIS Tanzania has been set up, and translations from English to Kiswahili, the national language, implemented. Users can now access market information from the 5 markets at <http://www.lmistz.net>. Market information linked to the Livestock Early Warning System advisories has created great interest among stakeholders taking into account the frequent droughts the country has been facing in recent years. The challenge this year has, therefore, been on how to bring more partners on board for institutionalization and sustainability of the system in the country. More sensitization was done through participation in an agricultural show in August, a stakeholder meeting in Dar es Salaam in September where 30 people attended, and a presentation made during the national livestock sub-sector stakeholders meeting held on the 3rd October 2006 in Dodoma. Consultative meetings at the ministry level have been done, and there are plans to support expansion of the monitoring to more markets, and promoting utilization of the market information by the Ministry of Industries, Trade and Markets. More stakeholders are to be brought on board, including the local governments under which the livestock markets fall. The Ministry of Livestock Development is planning to expand the monitoring of forage conditions for the expansion of the LEWS system that will be linked with the market information for development of the livestock sub-sector.

Results from current studies indicate that marketing remains one of the greatest challenges in the development of the livestock industry. 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 LINKS

project 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, Ethiopia, and Tanzania. The development, testing, implementation, and expansion of the system in these countries 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.

Development of a National Livestock Marketing Information System and its Accomplishments

In Kenya 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 training 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.

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 to keep custody of the hard copies of the data sheets. The data monitors code the data to text messages that they send via cell phones 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 prepaid card, the market monitors can also enter data directly into the internet through Postasurf, a facility provided by the Postal Corporation of Kenya. 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 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 may be downloaded and saved into a computer so that national organizations 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. With support from the Kenya Livestock Marketing Council (KLMC) and the Netherlands Development Organization (SNV-Kenya), the system has expanded to cover thirteen markets; however, the actual number of markets is fifteen since Nairobi has three markets.

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. Twelve presentations have been made at local meetings of livestock stakeholders and collaborators. 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, Arid Lands Resource Management Project Vétérinaires Sans Frontières (VSF) Suisse), and Food for the Hungry International (FHI).

Through the Nairobi Support to Emergency Preparedness and Response Project, 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, West Pokot, Turkana, Kilifi, Kajiado, Narok, and Laikipia, involving a total of 394 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 the expansion and sustainability of the system. During the workshops a total of 31 other markets were identified for inclusion into 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.

In Ethiopia, 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, by training of 23 market monitors for the nine PLI markets. However, most of the markets' (Dagahbur, Fik, Warder, Kebridahar, Gode and Charatti town) data collected were not able to reach regional headquarters due to a poor transport and communication infrastructure. Thus, we decided to monitor markets on a weekly basis, while market data would be available in the LINKS web portal on a monthly basis. Monitoring and reporting of three livestock markets (Jijiga, Dire Dawa and Moyale Somali) are actively being updated on a weekly basis. Similarly, 19 livestock market (Cheffra, Assyaita, Yalo, Welka Merer and Bati) monitors were trained for Afar region, and all the markets are actively reporting on a weekly basis. However, the challenge has been information dissemination to pastoralists and traders. Unlike the Somali region, Afar Community Information Centers are yet to be established by SC-UK and First Voice International, though there are immediate plans to functionalize the CICs in the future. In addition to this, four additional market monitors were trained to assume the responsibility of Dagahbur, Warder, Kebridahar and Gode markets after the former monitors show leniency due to communication difficulties.

Training on interpretation and utilization of forage data was carried out by a team from the Somali regional Save the Children-UK, Disaster Prevention and Preparedness and Food Security Bureau (DPPFSB) and Livestock, Crop and Natural Resources Development Bureau. They were provided with training on the selection and setting up of forage monitoring sites, forage data interpretation and utilization, and how to analyze the information. The forage and livestock marketing information is disseminated to communities regularly.

A rapid assessment of current livestock market information systems in the highland regions of Ethiopia was carried out. This was commissioned by amalgamated efforts of the Ethiopian Ministry of Agriculture and Rural Development and the

Texas A&M University system in a bilateral project on Sanitary and Phyto-Sanitary Standard and Livestock Meat Marketing (SPS-LMM), and Livestock Information Network and Knowledge System (LINKS) of the Global Livestock CRSP. All the parties involved identified the need to bring on board functional livestock markets in the highland regions of Ethiopia.

The objective of the assessment was to gain an insight into the existing livestock market information systems to help identify problems and opportunities towards the development of a unified national livestock market information system that builds upon what has already been put in place in the pastoral regions as a result of the recent programs carried out by the Ministry of Agriculture and Rural Development, Livestock Information Network and Knowledge System of the Global Livestock Collaborative Research Support Program (LINKS/GLCRSP) led by Texas Agricultural Experiment Station, Texas A&M University and various Non-Governmental Organizations.

A LINKS team conducted a field assessment in Southern Nations and Nationalities People's Region (SNNPR), Amhara, Tigray and Oromia Regions in the period between May 24 to June 15, 2006 using structured interviews with key informants including information providers at the key government offices, with traders, and with grass roots level livestock keepers.

The findings of the study are expected to help the Ministry of Agriculture and Rural Development fine-tune and improve ongoing efforts in the implementation of a standard Livestock Market Information System (LMIS) in the country. Some of the specific objectives included:

- Assessment of the current situation of livestock market information services in the highland regions Ethiopia.
- Evaluation of the current strengths and limitations in the provision of Livestock Market Information at the national and regional levels and identification of best practices.
- Generation of new ideas and information to design a standard and need-driven Livestock Market Information System.
- Identification and assessment of the information

needs of the current and potential end-users of livestock market information and whether or not these needs are being met now and by whom.

- Provision of new ideas for the improvement of existing livestock market information products to better respond to the needs of these users.
- Gathering of information about any existing institutional and legal frameworks for the generation of livestock market information at the various levels of the government.
- Understanding of the barriers that limit effective implementation of LMIS in order to ignite a process towards the development and institutionalization of a National Livestock Market Information System.

The following are the main findings from this study:

- There are significant overlaps and duplication of activities 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 collaboration and coordination, and poor working relationships among stakeholders and institutions involved in LMIS.
- The recent emergence of new Agricultural Marketing Agencies in the Regions, which among other things will coordinate the livestock market information system at the regional level, is a healthy development. It is an indicator of growing recognition of the importance of market-led development and linking producers to markets.
- Key organizations currently involved in Livestock Market Information in the highland regions include: the Bureau of Agriculture and Rural Development (Livestock and Cooperatives Departments), Disaster Preparedness and Prevention Bureau, Agricultural Marketing Agencies (new development), Bureau of Trade and Industry, and to a lesser extent the Central Statistical Authority (CSA).
- Most of the organizations are collecting not only livestock market information, but also other agricultural products such as cereals and horticultural crops. In fact, in most cases,

cereal market data is the primary information collected. Livestock market data is weaker compared to that of cereals.

- Livestock market prices are based on animal type, breed, class, sex and grade apart from supply and demand.
- Too much information is just collected and stored in raw format at government offices in hard copies, and it is not clear to most government officers the motive behind the whole exercise of collecting this information. The information is not packaged for dissemination to the desired beneficiaries.
- Long delays exist in data transmission from the markets to the government offices.
- Unless donor funded, livestock market monitoring and other agricultural market data collection, in general, are not a primary task and priority for many of the market monitors and their respective organizations.
- There exists a significantly high turnover rate of market monitors and experts mostly due to restructuring within the government offices.
- Lack of standards for data collection, even within the same bureaus, appears to be a significant challenge for the market monitoring processes.
- Most of the traders interviewed were in favor of the idea of creating a uniform, reliable LMIS and indicated a willingness to even pay minimal fees for the service provided it is regular, relevant and timely.
- 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 surrounding local markets but also about central and terminal markets in the country.
- There is a lack of strong and coordinated traders and civil society organizations as a strong mutual interest group to support LMIS. There are emerging cooperatives and associations throughout the country that could become a

force for the good of LMIS if their capacity and organizational skills are improved.

Accomplishments and lessons learned in organizing NLMIS systems

Kenya

The system started reporting in 6 markets and is now reporting in 13 markets. The target is to cover a minimum of 24 markets. LINKS has committed to continue supporting the 6 markets and to host the database. KLMC has sponsored training of data monitors and is supporting 7 markets. The FAO/ALRMP support to the emergency preparedness and response project continues to support trainings of monitors and district workshops in order to bring information closer to users, FARM-Africa has financed production of dissemination materials, while the University of Nairobi provides research capacity. The Ministry of Livestock and Fisheries Development continues to avail personnel for data monitoring and supervision. The coordinating committee continues to solicit support for the system and has secured support from some of the stakeholders.

There are a number of lessons learned in the implementation process. Among them is that for the system to be fully functional, it is important to get full support for market data monitoring in all the markets in the system while, at the same time, disseminating information collected for empowerment of users. Support by beneficiaries and institutionalization through policy formulation is key to building confidence and sustainability of the NLMIS. It is also important to conduct studies to determine how the system is impacting on the decision-making processes for different groups of users.

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 LINKS 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, developing a grading system based on defined animal characteristics, implementing 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 times involved in transporting animals from one market to another, estimating transfer costs, and forecasting how the markets are likely to perform in the future.

Ethiopia

All local key institutions at all levels of the government must be involved in the planning, development and deployment phases of the LMIS program to insure their ownership of the service. They should be encouraged to contribute to the necessary resources to increase efficiency of the system and to insure the sustainability and viability of livestock market information system. Limited donor support and technical assistance should be encouraged 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. Every effort should be made to design a simple but useful system that could be managed within the normal budget allocations of the government agencies that have the mandate for operating the system.

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 institutions can be self-sufficient to handle the whole system by itself. However, a single institution needs to be identified as the lead organization for the 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. A set of principles, guidelines and procedures will

need to be formulated to foster development and implementation of a coherent and need-driven information program.

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. A lead institution, preferably the counterpart of the above-mentioned agencies at the federal level, would have to be identified as the national home and the coordinator of the system with necessary political backing. Some of the regional agencies have already taken leading coordination roles in the implementation of Livestock Market Information at the regional 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 in order to avoid duplication of efforts and resources. These agencies need some technical backstopping and guidance in the preparation of technical and policy guidelines from the federal government and NGOs for the implementation of an efficient National Livestock Market Information system.

The IFAD Agricultural Marketing Improvement (AMIP) Project is being implemented in almost all regions in the country with a mandate that appears to offer a potential to be a springboard for promoting the development of a LMIS in the country.

Ministry of Agriculture and Rural Development, NGOs and donor agencies should work together to create a need-driven livestock market information system that serves producers, traders and policy makers. The system needs to have the freedom and the capacity to respond flexibly over time to private-sector needs.

High priority should be given to solving the institutional problem facing the livestock market information systems at the woreda level and local markets where data collection is initiated. The current data collection formats are very time consuming and would need to be reviewed and redesigned for information collected to be useful. A national livestock market information system should ultimately cover both domestic and international price information.

Every effort should be made to increase the

institutional capacity of the woredas both in terms of human development and equipment to ensure 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 staffs 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.

A national LMIS requires standardization of at 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 the USAID Southern Tier Initiative of MoARD and LINKS GLCRSP projects.

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

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 would be in finding ways to improve access of the market information to 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 utilizing mobile telephone technology to keep themselves updated on both local and terminal markets.

Lack of understanding of the client's specific information needs and poor system design could lead

to the failure of the LMIS. Information generated needs to be commercially useful, relevant, regular, reliable and on a near real time basis to satisfy the needs of the users

Making the present livestock market information system stable and exploring possibilities of linking it to other key agricultural produce markets in the country such as grain is important.

The use of modern ICTs in LMIS is quicker and cost effective to be able to transfer information on a near real time i.e. fax, e-mail, online, internet and phone. Using the modern ICTs eliminates the chances of losing 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 face information losses or misdirection and distortion. The amount of field and deskwork required to produce livestock market information could be reduced through automation programming, processing, and dissemination using a software/hardware architecture that makes use of the state-of-the-art telecommunication technologies.

Emergence of the 2005-2006 drought in Kenya

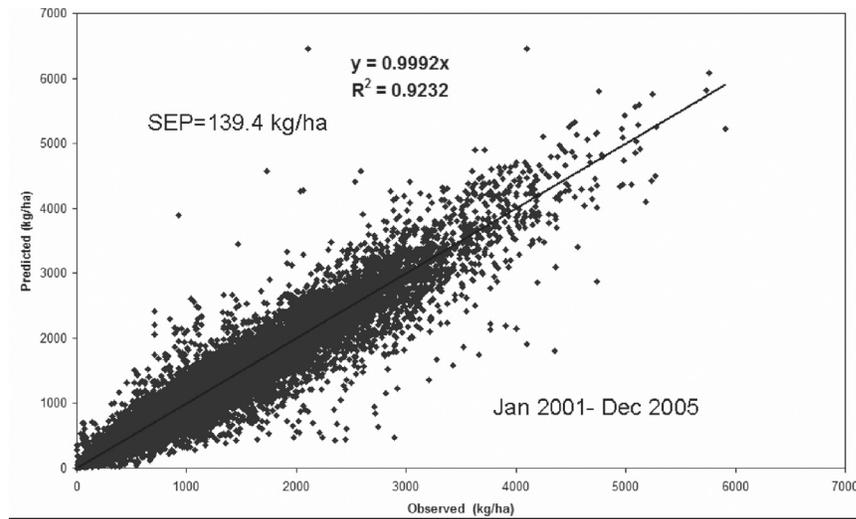
Increasing frequency of droughts and a decline in the capacity of traditional mechanisms to deal with this situation is increasingly becoming a serious threat to the livelihoods of a majority of people who depend on livestock. Over three million people were faced with starvation due to the November 2005 to March 2006 drought in Kenya. The livestock early warning products produced by the Livestock Early Warning System, a component of the LINKS system, were able to effectively track the conditions 3-4 months before the drought. Available forage and weather data showed 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 forecast 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 the Famine Early Warning System Network (FEWSNET) 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 were highly correlated with the PHYGROW available forage simulated model outputs with correlation coefficients (R^2) of 0.96 and standard error of prediction (SEP) of 161 kg/ha. Using the data from January 2001 to December 2005 on the 60-day forecasts, and available forage matching the forecasts, indicated that the Auto Regressive Moving Average (ARIMA) time series forecasting methodology provided suitable projections well within normal sampling errors. The observed R^2 and SEP (kg/ ha) values for the 60-day forecast of grazeable standing crop were 0.92 and 139 respectively (Figure 3).

Influence of water availability on livestock migration in Northern Kenya

A survey was conducted in Northern Kenya to assess the contribution of water availability in determining livestock migration in some of the Livestock Early Warning System project monitoring sites. Preliminary results indicated that water was ranked second to forage availability as a factor determining pastoral livestock migration. Water availability was considered the overriding factor in the decision of moving away from a grazing radius for only 2.5% of cases reported in this study. Forage availability was the primary consideration in influencing decisions to move livestock in 71.4% of the sites and 97.5% of the livestock movement events. Forage was the limiting factor on how long

Figure 3. Relationship between observed and predicted 60-day forage from January 2001 to December 2005.



animals remained in an area. In some sites, livestock stayed away for over 2 years without returning home and covered distances of up to 120 km from the homestead in search of pasture. Water quality (salinity, turbidity) for livestock plays a minor role in determining when and where to migrate. There was a conscious decision by the grazing communities to first utilize forage in areas without permanent water during the rain period and then gradually move towards areas with permanent water availability as the dry season progresses. Findings from this study indicate that the water resource database is not up-to-date and may need attention in order to address development and environmental conservation issues.

Capacity Building/Institutionalization of LINKS system within partner institutions

Objectives. Develop the capacity for private and public institutions to fully integrate information from the LINKS system as part of their routine decision-making process.

Progress. The major thrust was to integrate and promote the usage of information and communication technologies among various stakeholders in Eastern Africa by designing a web-based livestock information delivery system responsive to the real

needs of the users. Given the integrated nature of LINKS' information and communication technology (ICT), human and organizational capacity was built in terms of deployment of ICT equipment, use of that equipment, reporting/analysis, and distribution of information. The identification of key organizations and creation of the technical capacity was addressed in the core program and Module One. We were able to infuse SMS capable cell phones,

as well as GPS and WorldSpace radio units, at key communication nodes within the livestock market chain of Eastern Africa based on the organization infrastructure emerging in the region. To address institutionalization issues, efforts were concentrated on advising key organizations that formed partnerships. We were able to expand the LINKS system to Tanzania by setting up a country server based in Dar es Salaam. Region-wide focus on training of key individuals at pilot test markets and within the appropriate unit of the organization in all countries targeted in LINKS was carried out. This training primarily focused on use of the cell phone SMS, designing and reporting codes, analyzing the data, report writing, and information dissemination. To help this process, we used the communication hub established at the International Livestock Research Institute (ILRI) to allow video conferences and subject matter experts to confer. The goal was to link a series of key personnel in the array of organizations into this conferencing system to promote planning, distance education, and regional coordination of market and trade issues. It was important to build organizations that can sustain these systems given their recurrent costs. Simple email service was the initial mechanism for coordination, but the goal was to establish a network of market and trade organizations that communicate with each other and provide a transparent information flow to all

livestock producers in the region.

Training sessions and workshops were planned in the region to train national ministry staff in the use of the new tools and technologies to create the skills needed to form rational policy and monitoring the flow of livestock throughout the region, and to ensure the sustainability of the system after the project ceases. We specifically trained market monitors in use of the cell phones and SMS reporting system. The Ministry and trade commissions/agencies/authorities were trained in data acquisition, use of the LMMO system, and analysis/reporting. We assisted the livestock marketing agencies in linking the information with media that impacts pastoral communities with focus on pastoral outreach radio system, rural radio stations, newspapers, WorldSpace radios and possibly television jointly developed by the Ethiopia Livestock Marketing Authority (LMA) and the Kenya Livestock Marketing Services Division, Kenya Livestock Marketing Council, FEWS NET, and other critical NGOs in the region.

To help build future human capacity in livestock marketing, we identified and funded two students at the University of Nairobi. These students worked on issues focused on development of fundamental information on market function and price efficiencies of key markets and impacts on pastoral, trader and broker market decisions. We carried out a series of pastoral community sensitivity meetings via our two in-country program officers where the focus was to discuss with them the modality of reporting market information along with the array of other products produced by LINKS such as the forage reports from the LEWS component and the disease warning issues.

Beef Cattle Marketing Behavior in Pastoral Areas of Kenya: The Role of 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. The rationale for the study was based on the observation 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, and was exacerbated by failure to effectively use existing media and complement these with emerging information communication technologies to disseminate the information. The study used two sets of data. The first set of data 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 of 1,233 transactional survey data collected between September 2004 and September 2005 from three livestock markets in Kenya: Nairobi, which is the main terminal market in Kenya, two other pastoral markets of Garissa in the northeastern rangelands, and Isiolo in the eastern rangelands. The samples were based on beef cattle presented and sold in the three markets. The data were collected randomly in each of the markets by trained LINKS market monitors. Results indicated that a majority of the respondents (73%) had access to radio, while 28%, 11% and 10% had access to a cell phone, 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 daily, 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 length of trip, 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. The results from the transactional data, analyzed using regression analysis, are given in the table below. Almost all the attributes were negatively correlated to the price, class, sex, volume, castration, grade and market. Other reported items, such as castration and breed type were not significant. This could have been associated to the uniform/single breed available in each market (Table 1).

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 1% change in class. Males fetched higher prices than females by a premium of 0.4% on average. 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. The grade is used to reflect the influence of the cattle body condition scoring method (a rough 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. Analysis indicates that a 1% increase in volume decreased the average price by approximately 0.235%. The breed variable (Boran, Zebu, Mixed) had a positive coefficient of 0.037 and standard error of 0.010 indicating that mixed breeds (crosses between the other breeds) commanded higher prices than the local breeds such as Boran and Zebus. The non-castrates fetched higher prices than castrates. The non-castrates fetched higher prices because they were in demand both for breeding as well as slaughter purposes. In most of the cases, males for breeding purposes were priced highly. The overall regression

model explained about 82% of the total variation in the dependent variable. Regression model on factors influencing commercial offtake rate results showed that market information had a positive response to livestock offtake rates, though this response was significant at 10% level with 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.

The study has identified the existing sources of information and extent of their use by producers and the physical attributes of beef cattle considered while selling animals. 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 which is important for pastoralists if they have to respond to the needs of the market. LINKS has consistently responded to the need for information through improvements in geographical coverage, accuracy, reliability, and timeliness that will provide a national livestock marketing information system tailored to meet the needs of livestock producers.

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

Table 1. Regression results of the semi-log price model for beef cattle

X	Variable	Unstandardized Coefficients		Standardized Coefficients	T value
		Beta	Std. Error	Beta	
	(Constant)+	10.170	0.067		151.036
1	Market+	-0.149	0.012	-0.192	-12.114
2	Class+	-0.531	0.013	-0.686	-42.229
3	Breed+	0.025	0.010	0.037	2.592
4	Volume+	0.000	0.000	-0.235	-14.388
5	Sex+	0.399	0.066	0.087	6.018
6	Castration	-0.027	0.016	-0.026	-1.691
7	Grade+	-0.147	0.009	-0.249	-16.861

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

The second study carried out was on “Assessing Market Integration in the Presence of Transaction Costs: The Case of Pastoral Livestock Markets”. 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 LINKS project 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 co-integrated 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.

Summary of Year's Accomplishments

- Refined SMS text messaging market reporting coding protocol
- Trained market monitors in the following markets:
 - Kenya - 71
 - Ethiopia - 51
 - Tanzania - 34
- Have established a SMS steady reporting flow from 13 markets in Kenya, 10 markets in Ethiopia and 5 markets in Tanzania
- Have continued to maintain LEWS' output by preparing monthly situation reports, 10-d internet reports, and reports to RANET and ALIN to Worldspace radios
- 96.2 GB of data downloaded between July 2005 to July 1, 2006 to countries with Kenya and Tanzania the greatest users in East Africa and .edu sites the largest. Total number of visits to this page was 188,463, (<http://cnrit.tamu.edu/>).
- Submitted 3 publications 1 book chapter, 1 journal article, 10 proceedings, 6 research briefs, 12 bulletins, 36 advisories, 8 LEWS' presentations, 18 LINKS' presentations.
- Save the Children UK and FARM Africa became important reporting entities in collaboration on market price reporting for livestock in Ethiopia

GENDER

Transparency in livestock market information to be delivered through a variety of media including

voice (radio, community speakers), print (bulletin boards, newspapers) to the population as a whole, regardless of gender and age, is one of the primary goals of this project. In doing so, both men and women, old and young can come to understand the information and jointly contribute to the decision making process within social norms of their respective clans, communities, and families. When meetings are held with pastoral communities, we have insured that women are involved in the discussion in a format that does not violate customs or traditions for discussing issues. In addition, both verbal and print reports are placed in locations that are accessed by women as well as men.

The LINKS project has maintained and expanded the organizational network created under LEWS, retaining leadership by the women that were so instrumental in maintaining the LEWS efforts in Northern Tanzania, Kenya, Uganda and Ethiopia. Attempts will be made to study the impact of LINKS market information on pastoral family decision making. The study will stratify decision making by family members and seek to understand potential impact on household income status.

POLICY

Lack of information flow, equality of access to critical livestock market information, and associated analysis on forage conditions, disease outbreak, conflict and water supply have all been listed as major strategic needs in the countries targeted for the LINKS project. All major national and international institutions have stressed that livestock market issues are of prime concern, as they have a large impact on the well being of pastoral communities. A review of all the countries strategic plans indicates the need for a well defined livestock market information system that encompasses more than just market prices, and that addresses issues impacting market infrastructure and functionality such as drought (forage and water), disease, and conflict. Through work this past year we have been able to designate LINKS LMIS technology as the primary tool to manage LMIS obligations in the systems being set up within government policy for Kenya, Ethiopia, and Tanzania. Members of the LINKS team have been integral members of policy

formation boards within these respective institutions. We have been provided office space and access to both these key organizations in the region to place our research technical people side by side with key decision makers in each institution to insure that LINKS addresses their needs for price and volume reporting systems. We have assisted these agencies in addressing issues of information delivery, standardization of sampling for prices by kind and class of animals, as well as identifying and pursuing critical research needs of these organizations. ASARECA has endorsed the LINKS concept as a major need within the context of the member Nation's strategic plans.

OTHER CONTRIBUTIONS

Contributions to US agriculture. The techniques being pursued in the LINKS project once stabilized will have direct application in new emerging grazing land and livestock related monitoring needs for agricultural bio-security in the USA. The lessons learned from LINKS will have a direct bearing on this suite of activities, and we anticipate that tools and techniques will be directly transferred to these programs. We are anticipating that the new forecasting technology being pursued in LINKS will lead to a new concept being developed in USDA NRCS, where the National Resource Inventory may move to a near-real time system if the techniques we develop are successful. The methodology for developing integrated communication and monitoring systems has application for a wide array of programs both in the USA and around the world.

Contributions to host country. The research team within LINKS will document impact at levels most appropriate for the technology deployed. The LINKS team has made attempts to establish baseline responses of major institutions and worked with partner institutions to outline expected pathways to impact. Some of these measurement instruments were designed to establish if expected impacts did or did not occur, and to identify if impacts were positive and negative. The intensity of impact assessment was guided largely by funding levels provided by the project. However, in the future,

we will focus primarily on market efficiency as a measure of benefits to the host countries. We do have the opportunity to conduct a sector level impact assessment. Our goal is to have an analytical framework in the Kenya Agricultural Sector Model with updated livestock sector secondary data to allow ex ante analysis reflecting different levels of adoption, and the subsequent changes in marketing behavior of pastoralists, traders, and exporters should the opportunity present itself.

We anticipate that the adoption of the LINKS LMIS technology in Ethiopia, Kenya and Tanzania will help them advance their plans for improving livestock market information and infrastructure development in each country. With our tools and training, the respective institutions will be able to advance further and faster toward their stated strategic plans for livestock marketing in each country.

LEVERAGED FUNDS AND LINKED PROJECTS

ILRI – VSAT broadband width payment for LINKS hub in Kenya (\$1200/month * 12m each year) - \$14,400

NRCS provided \$100,000 to help cover some of the programmer salaries used in the support of this project.

Texas A&M University provided a 9-month Ph.D stipend for Ann Zhang conducting research on enhancing the PHYGROW model to predict animal conditions - \$13,677

USAID Ethiopia Mission funded Save the Children (The Pastoralist Livelihoods Initiative Early Warning Project) – UK \$3 million USD and LINKS received \$ 300,000 for the 2005/06 fiscal year in order to expand the livestock early warning coverage in the country.

USAID has launched a three year project on Sanitary and Phytosanitary Standards and Livestock and Meat Marketing (SPS-LMM) program in Ethiopia. LINKS GLCRP is conducting a component of the project on national livestock market information assessment. A total of \$85,000 was allocated for the component during the 2005/2006 fiscal year.

USAID funded a Pastoral Engagement,

Adaptation and Capacity Enhancement (PEACE) Project in Afghanistan at a level of \$1,000,000 per year. This project is associated with, but not directly a part of, GL CRSP. This project will, among other things, replicate the LINKS/LEWS' methodologies and implement them into Afghanistan's Kuchi nomadic system. This project started in July 2006.

TRAINING

Degree Training

Ochieng, Bridget, Kenya, F, University of Nairobi, Agricultural Economics, Msc
Komen, Mathew, Kenya, M, University of Nairobi, Agricultural Economics, Msc
Omaria, Rose, Uganda, F, Makerere University, Veterinary Science, Ph.D.
Zander, Kristen, USA, F, Texas A&M University, Agricultural Development, M.Sc
Zhang, Ann, China, F, Texas A&M University, Range Science, Ph.D.
Mnene, Wiliam, Kenya, M, University of Nairobi, Range Science, Ph.D.

Non-Degree Training

Kenya

25-October 2005: Training workshop stakeholders training on LINKS tools, products and protocols. Nairobi, Kenya. Facilitator: Robert Kaitho. Attended by 22 participants (19 male, 3 female).

26-October 2005: Workshop Livestock Marketing Information System. Nairobi, Kenya. Facilitator: Robert Kaitho. Attended by 10 participants (8 male, 2 female).

07-11 November 2005: LINKS/LEWS presentation at IGAD LMIS Training workshop, ICPAC Nairobi.

16-17 November 2005: LINKS/LEWS presentation at FARM-Africa workshop, Meru.

7-24 November 2005: NLMIS sensitization workshops in 14 districts supported by FAO/ Arid Lands Resource Management Project (394 participants from different organizations attended).

01-02 December 2005: LINKS/LEWS presentation at European Commission-FAO technical review workshop, Nairobi.

05-09 December 2005: Training of monitors' workshop at AFRALTI, Nairobi supported by FAO. Participants who attended the workshops included 52 data monitors and 20 supervisors. The data monitors were drawn from 35 markets in 19 districts within 4 provinces.

21 December 2005: LINKS/LEWS presentation at KARI livestock marketing proposal review workshop, Nairobi.

March 2006: LINKS/LEWS presentation at the Global Working Group of the Sustainable Agriculture and Rural Development initiative at Namanga.

April 2006: LINKS/LEWS presentation for SNV at ILRI campus.

23 May 2006: LINKS presentation for Terra Nuova/AMREF team at Terra Nuova office, Nairobi.

24 May 2006: LINKS presentation for CARE Kenya at ILRI campus

25 May 2006: National Livestock Market Information System stakeholders' workshop training on LINKS tools, products and protocols at Nairobi, Kenya. Facilitators: Robert Kaitho and Gatarwa Kariuki. Attended by 39 participants (29 male, 10 female).

31 August – 1 September 2006: LEWS presentation on "Forage Outlook for the October to December 2006 season" at the 18th Climate Outlook Forum for the Greater Horn of Africa (GHA COF18), Intercontinental Hotel, Nairobi, Kenya. Presenter: J. N. Ndung'u

Ethiopia

17-19 November, 2005: Training Workshop on livestock market monitoring protocols and methodology training for LMIS-LFMD market monitors. Addis Ababa, Ethiopia. Facilitator: Abdirahman Ali. Attended by 6 participants (3 male, 3 female).

30 November - 5 December, 2005: Training workshop Livestock on livestock market monitoring protocols and methodology training for LMIS-

LFMD market monitors. SNNPR and Oromiya Regions, Ethiopia. Facilitator: Abdirahman Ali. Attended by 9 participants (9 male, 0 female).

26- 28 January 2006: Training workshop on livestock market monitoring protocols and methodology training for LMIS-LFMD market monitors. Addis Ababa, Ethiopia. Facilitator: Abdirahman Ali. Attended by 4 participants (1 male, 3 female)

10 - 16 April 2006: Training workshop on livestock market monitoring protocols and methodology training for PLI-LINKS GLCRSP monitors. Afar Region, Ethiopia. Facilitator: Abdirahman Ali. Attended by 9 participants (8 male, 1 female).

17 - 18 June 2006: Training workshop on livestock market monitoring protocols and methodology training for Somali Region partners, Somali Regional State, Jijiga, Ethiopia. Facilitator: Abdirahman Ali. Attended by 23 participants (22 male, 1 female).

September 2006: LINKS Presentation technical paper on “National and International Opportunities and Challenges of Livestock Marketing in Ethiopia” at Ethiopian Society of Animal Production (ESAP)’s 14th Annual Conference on “Institutional Arrangements and Challenges in Development of Market-oriented Livestock Agriculture in Ethiopia” held at Ethiopian Institute of Agricultural Research (EIAR), Addis Ababa. Presenter: Abdirahmana Ali.

22 – 23 September 2006: Workshop on the findings of Rapid Assessment of Current Livestock Market Information Systems in the Highland Regions of Ethiopia at Rift Valley Hotel, Nazret. Facilitators: Abdi Jama, Laban MacOpiyo, Abdirahman Ali and Ahmed Ali. Attended by 46 participants (44 male, 2 female).

Training on LINKS protocols and products. Bekele Molla Hotel, in Nazret. Facilitators: Abdi Jama, Laban MaCopiyo, Abdirahman Ali and Ahmed Ali. Attended by 23 participants (21 male, 2 female).

Tanzania

8-10 November 2005: Training workshop for stakeholders training on LINKS tools, products and protocols, Dar es Salaam, Tanzania. Facilitator:

Robert Kaitho. Attended by 34 participants (28 male, 6 female).

20-22 September 2006: Training workshop for stakeholders training on LINKS tools, products and protocols, Dar es Salaam, Tanzania. Facilitator: Robert Kaitho. Attended by 29 participants (26 male, 3 female).

COLLABORATING PERSONNEL

Ethiopia

Shide, Ahmed, Pastoral Commission, Somali Region

Adamasu, Dubale, FarmAfrica, Field Coordinator
Ali, Abdirahman, LINKS-GLCRSP, LINKS
Research Assistant

Eshetu, Jemberu, Livestock Marketing Authority, BS,
Team Leader, Market Research. and Follow-up
Abdifatah, Ahmed, Save the Children-UK, Early
Warning SC-UK Somali Region Manager

Haile, Getachew, Oromia Agricultural Research
Institute, Research Officer

Mulugeta, Asefa, Ministry of Agriculture and Rural
Development (MoARD) Agricultural Input
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SUSTAINABLE MANAGEMENT OF RURAL WATERSHEDS: BIOPHYSICAL, LIVESTOCK AND HUMAN INTERACTIONS IN THE RIVER NJORO WATERSHED

NARRATIVE SUMMARY

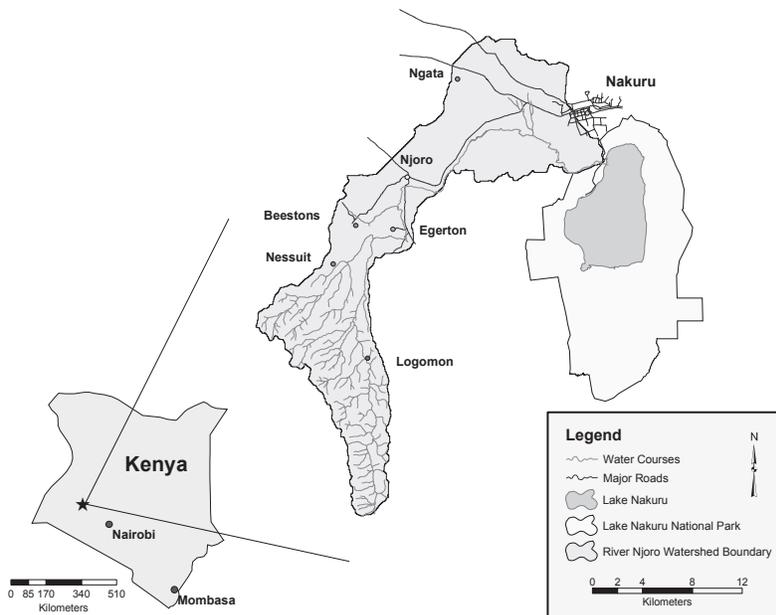
Results are presented from a cooperative research endeavor wherein faculty and scientists from three US academic institutions (University of Wyoming, University of California-Davis, Utah State University), two Kenya academic institutions (Moi University and Egerton University), and two Kenya governmental organizations (Kenya Fisheries Department and Kenya Wildlife Service) collaborated on interdisciplinary research for sustainable watershed-based management. This multidisciplinary team is subdivided into four components: watershed hydrology, ecology, stakeholder involvement, and socio-economics. The Njoro watershed (Figure 1) serves as the research test bed for a variety of research and developmental outcomes, and is being developed as an experimental

watershed where interactions among ecological and hydrological dynamics may be quantified. Analyses in the past year focused on defining human and watershed-based metrics resulting from policy decisions and resulting land cover change. Numerous field studies have provided basic information to a range of simulation and conceptual models to build a strong scientific understanding of the watershed system, as well as provide key information to decision makers for policy guidance and effective land management.

This year's effort was geared towards assembling representative conceptual and mathematical models of the biophysical and human dimensions of the watershed, as they relate to watershed and human health and sustainability. Watershed health is defined

as having the capability of supporting short- and long-term hydrologic and ecologic function. The human aspects of the project are aligned with minimizing risk to economic instability, and health hazards associated with water-borne diseases. Livestock are a central component to both the biophysical and human models with which SUMAWA is working, and will be embedded in the modeling tools for inclusion in decision support and outreach products generated in the coming year. SUMAWA researchers are developing a full suite of biophysical and

Figure 1. Map of the Njoro Watershed



human-related research for the purpose of creating a comprehensive watershed model that may be translated and transferred to stakeholders and policy makers who are the primary determinants of watershed and human health in the Njoro watershed.

RESEARCH

Research and outreach efforts in the 2005-2006 year were targeted to provide a basis for improved decision making for sustainable watershed management in terms of both human and ecological health. Several important topics that were identified in the early years of the project were addressed directly, including a detailed analysis of human health risks. The SUMAWA project was instrumental in the formation of the River Njoro Water User Association, which will serve as the primary point of contact for linking watershed stakeholders with scientists and policy makers. In addition, formal linkages have been made between the project and key policy makers and management agencies operating in the watershed, including the Ministry of Health and the Rift Valley Water Management Authority. These linkages will enable us to more directly link scientific outcomes with policy makers in order to stimulate positive changes.

Field- and lab-based approaches were pursued in the past year. A comprehensive watershed-monitoring program was maintained, including data collection for climate, runoff, water quality, human health, conservation practices, livestock utilization and impacts, and ecological integrity. Results from both field data analysis and modeling exercises indicate that there is a high degree of variability in indicators of health throughout the watershed.

Activity 1. Conceptual and mathematical model development of the dynamics governing watershed health, economic stability, ecological systems, and stakeholder perceptions and management strategies.

1.1 Effects of livestock grazing on the hydrological characteristics within the River Njoro Watershed: Problem Statement and Approach. The activity was

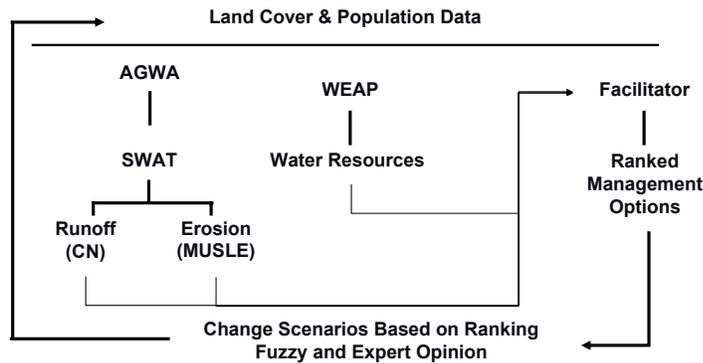
to assess the capacity of the riparian vegetation to reduce nutrient and sediment input into the river at livestock watering/grazed and non-grazed sites, as well as the capacity of in-stream vegetation to take up nutrients.

Accomplishments:

- Riparian strip vegetation species composition 30m from the centre of the stream, on either side of the stream at watering/grazed and non-grazed sites identified and documented.
- Percent vegetation cover at livestock watering/grazed and non-grazed sites quantified.
- Generation of 30 m stream cross-section profiles.
- Infiltration measurements at disturbed and non-disturbed sites.
- 589 topsoil, subsoil and sediment samples were taken for laboratory analyses to assess the capacity of the riparian vegetation to reduce nutrient input into the river at disturbed and non-disturbed sites. A soil condition index that identifies soils as fertile or not fertile has been generated. Wet chemistry on 30 of the soil samples has been done and results received. Prediction of the same variables (pH, nitrogen, phosphorus, particle size, exchangeable Mg²⁺ and Ca²⁺ ions and organic carbon) on the rest of the soil samples is yet to be done (results on prediction of the wet chemistry variables on the rest of the samples still held at ICRAF laboratories in Nairobi pending payment of wet chemistry analyses costs).
- Width of stream at disturbed and non-disturbed sites measured.
- Width of the riparian vegetation on either side of the stream measured.
- Land use activities within 30m from centre of the stream and beyond recorded
- Sediment samples of three tributaries (at Logoman, Ruguma and Little Shuru) on River Njoro collected and sent for laboratory analyses to determine which sub watershed/ tributary contributes much sediment to the main stem.

Progress. The activity was successfully accomplished and data are being analyzed to assess

Figure 2: Land Cover & Population Data



the capacity of the riparian vegetation to reduce nutrient and sediment input into the river at livestock watering/grazed and non-grazed sites. A first draft of a MSc. thesis for Eric Enanga is being written.

1.2 Water Evaluations and Planning Model. Efforts towards developing decision-support system modeling (Figure 2) this year were focused on technical capacity building among Egerton University and Ministry of Water personnel in integrated water resources and demand evaluation and planning analyses, using the WEAP21 modeling system. A series of general model development and hands-on input data collection, analysis, and data preparation training workshops, using the preliminary Njoro WEAP21 model application, was conducted over 11 weeks from late March to late June 2006 at Egerton University for SUMAWA students, researchers, a consultant, and Ministry of Water engineers and staff from the Rift Valley Water Resources Management Authority (WRMA) in Nakuru. The training was prepared by Dr. Jenkins and carried out by Niels Riegels, an experienced water resources systems engineer with extensive GIS and water resources modeling experience in California. Mr. Riegels was recruited as a research assistant to the team on leveraged funding at no cost to the project, to go to Egerton for 3 months to work collaboratively under the WRMA MOU to help improve technical modeling skills.

The training was well attended and well received, especially by WRMA staff and SUMAWA

students. Understaffing at WRMA, combined with a major re-hiring of staff in July, and limited prior computer modeling experience has meant that additional technical support will still be needed before WRMA-Nakuru are in a technical and staffing position to take on WEAP21 modeling on their own. Discussions regarding the WRMA contracting out the work to complete an updated Njoro WEAP model to technical consultants were initiated. This may be the most appropriate way for the WRMA to apply this tool to the

Njoro and other watersheds where they are keen to enhance quantitative analyses to support water resource decisions, which they are responsible for, such as basin water allocation planning, and water withdrawal and use permitting.

Of note, two workshops and resultant technical memos on population trends for demand estimation and methods for using and manipulating historical hydrologic stream flow records for WEAP model inputs for the Njoro watershed were conducted, prepared, and shared with the training participants and WRMA. An inventory of water service providers operating in the watershed identified over 30. A tool and approach was developed and tested to characterize water and wastewater system infrastructure, resources, operations, and demand components of each water service provider. So far, data for characterizing the demands, sources, and infrastructure for 9 service provider systems in the watershed have been collected and reported. This work was expected to be completed this past year, however, the loss of one of the students and the unavailability of WRMA staff during the summer caused significant delays. Once the remainder of the systems are characterized, necessary data for configuring an updated and complete Njoro watershed WEAP model application will be available.

1.3 Evaluation of Soil Erosion Risk using the RUSLE Model: Problem Statement and Approach. Many of the land management actions in the Njoro have the potential to lead to enhanced soil erosion and downstream sedimentation. For example,

grazing impacts on upland watersheds and trampling of near-channel areas is a significant contributor to both surface erosion and rilling, as is bed and bank failure leading to poor riparian condition. In the Njoro there has also been a widespread transition of forest to agriculture, which has the potential to increase soil erosion dramatically. The adequate mapping and modeling of erosion risk zones will be of benefit to local managers and stakeholders, and will provide a metric to track for the short- and long-term tracking of watershed health.

Progress. A GIS modeling framework has been implemented in the Njoro that uses the MSLE modeling framework, a variant of the RUSLE model. The two models share the core mathematical representations of erosion, the main difference being that RUSLE is a stand-alone system, while the MSLE implementation is embedded in the Soil and Water Assessment Tool (SWAT), which has been calibrated for hydrological response on the watershed (see 2004-2005 Annual Report). A spatially distributed map of soil erodibility following the MSLE modeling system has been adequately completed. Inputs to the RUSLE (RUSLE 2.0) model have been fully captured in GIS, and the models themselves installed on computers in Kenya and the US.

We are currently re-evaluating the need to fully implement the stand-alone version of RUSLE given that the SWAT model provides an effective and stable platform for modeling erosion, and one that is fully linked to ongoing hydrological modeling efforts. The goal of this research activity was to identify erosion-prone areas by modeling the combined effects of rainfall intensity, soil erodibility, landscape structure, and agricultural management based on the principles of the Universal Soil Loss Equation. The remaining research question in this area is whether continuing to build erosion models on two platforms (RUSLE and SWAT-MSLE) is appropriate, or if the SWAT-MSLE approach provides a robust and defensible scientific platform.

1.4 Development of Biological Monitoring and Assessment Tool (BIOMAT) for River Njoro Watershed.: Problem Statement and Approach. This activity was part of the assessment of the trends in watershed health and is part of the ongoing lake and river monitoring. It focused on the development of a water

quality map that will be used as a visual presentation to the stakeholders. Maps of water quality provide more than just a picture of the present state of the environment and can be used to identify stream reaches that are potentially environmentally sensitive or the best sites to concentrate restoration efforts.

Progress. This activity focused on the development of a Biological Monitoring and Assessment Tool (BioMAT) for the Njoro watershed of the Lake Nakuru Basin based on the Biological Monitoring and Assessment Program (BioMAP) developed in Canada by Griffiths (1996), and the Rapid Bioassessment Protocols (RBPs) developed by the Assessment and Watershed Protection Division of the Environmental Protection Agency (EPA) in the USA (Plafkin et al., 1989). Macroinvertebrate distributions and proportion (%) of natural riparian vegetation determined by GIS analysis will be used for mapping River Njoro water quality. Classifying and mapping stream water quality is a prerequisite for water quality management. It is difficult to manage that which cannot be identified and visualized.

Accomplishments:

- A total of 93 month of May samples for refined benthic macroinvertebrate taxonomic work collected.
- 67 samples processed, sorted and benthic macroinvertebrates positively identified to family level.
- A criterion for assigning sensitivity values to the benthic macroinvertebrates in the river Njoro watershed and lake Nakuru basin was developed.
- Initial map analysis used to estimate the density of riparian vegetation (within 50 meters of the stream) along the complete length of the river course of the stream by GIS analysis in University of Wyoming.

The following activities are yet to be accomplished but are being carried out, and are slated for continuation in future project years: relate water quality to riparian vegetation density; classify and validate water quality along the river based on the regression relationship between water quality and the proportion (%) of natural riparian vegetation.

A draft MSc proposal for Charles Kigen to finalize the remaining parts of “Development of Biological Monitoring and Assessment Tool (BIOMAT) for River Njoro Watershed” has been written and is scheduled to be submitted to the Faculty of Egerton University in the coming year.

Activity 2. Ongoing data collection and interpretation to better understand watershed systems dynamics and establish a true experimental watershed.

2.1 Assessment of Groundwater Potential and Monitoring of Groundwater Levels Fluctuations within River Njoro Watershed: Problem Statement and Approach. This activity focused on the assessment of the overall potential of groundwater resources within the watershed, its availability and accessibility for use by the stakeholders, and its linkages to and control of river flow (water yield). One of the basic objectives of this project is to quantify the amount of water that would be available for the stakeholders, with a major source of such water being groundwater. Stakeholder engagement activities have clearly demonstrated that this is a critical and high priority for all members of the watershed. The biophysical components of the watershed are equally reliant on water resources, and preliminary modeling and data analysis have shown that groundwater and near-surface control are the driving factors for river flow and annual discharge. These findings underscore the importance of groundwater to the Lake Nakuru National Park and to riparian communities.

The objective of this activity was to assess the overall potential of groundwater, thereby enhancing the hydrologic database for effective planning and management of the watershed. It would also result in the enhanced collaboration with the personnel in the water office in Nakuru, thus assisting in the development of the groundwater model, especially water balance, infiltration, river base flow, recharge by precipitation, and also the surface water-groundwater interactions.

Progress. To satisfy this objective, a range of field and lab activities have been completed. A borehole census has been ongoing, which to date has resulted in the spatial identification of over 150 boreholes

(wells) in the watershed alone. Detailed hydro-geological characteristics (such as aquifer levels and extent, natural discharge and recharge zones, surface water divide, groundwater divide, and hydrologic interconnectivity for the watershed) have been developed based on field records of depth to water table and the estimation of the piezometric surface. A water quality assessment of groundwater collected from various boreholes in the watershed is ongoing with expected results forthcoming. Preliminary maps in GIS format of the distribution of the boreholes in the watershed have been created and are being modified as field efforts continue. Two pump tests have also been carried out in collaboration with the Water Office in Nakuru, with the data analysis forthcoming.

2.2 Assessment of riverbank stability at disturbed and non-disturbed sites in the upper and middle reaches of River Njoro watershed: Problem Statement and Approach. The activity was to assess riverbank stability and assist in initiating ecological rehabilitation process in the watershed. The activity assisted in the identification of riverbank sites for rehabilitation. The activity also assessed the effect of livestock on the stability of riverbanks.

Progress. Variables required to generate stability index i.e. bank height, bank angle, bank percent vegetation cover and bank substrate in the upper and middle reaches of River Njoro have been identified through literature and field experience from the past several years of data collection efforts. A field program for measurement and monitoring was established and carried out with a repeated measures survey strategy in the past year. Stability indices of disturbed and non-disturbed sites in the upper and middle reaches of the River Njoro are being generated based on field metrics.

The activity was successfully accomplished and data are being analyzed to assess riverbank stability at sampled sites and identification of riverbank sites for rehabilitation. A first draft of an MSc thesis for Eric Enanga is being written and should be submitted to the Faculty of Egerton University in the coming year.

2.3 Evaluation of the impact of livestock grazing and trampling on structure and function of the riparian vegetation in the upper and mid-portions of the

River Njoro. This activity was combined with the activity reported above under the heading “Effects of livestock grazing...” Please refer to that section for the report.

2.4 Determination of temporal and spatial dynamics of waterfowl as a measure of proper functioning of riparian habitats: Problem Statement and Approach. Biological species are indicators of ecosystem health, and their spatial and temporal distribution and species dynamics are influenced by habitat quality. River Njoro watershed is a critically important biodiversity conservation area, whose fragmentation is leading to biodiversity loss and poverty prevalence. Monitoring avifauna temporal and spatial distribution will be used to document watershed health. Results from this activity will be used in the development and refinement of the BIOMAT tool, as described earlier in this report.

Progress. Fieldwork related to the collection of and ringing of birds in Eastern Mau using mist nets was carried out from the 4th to 26th of August 2006. 240 birds in various fragments in Nessuit, Sigotik, Sigaon, and Logoman Riparian zones of River Njoro watershed were ringed and identified, with the data entry and cleaning completed, and preliminary analyses begun.

Ms. Milkah Faith Ngugi has completed the portion of her MSc thesis entitled “Effects of Eastern Mau Forest Fragmentation on Avifauna in River Njoro Watershed, Kenya,” with an anticipated submittal date of the thesis for review by her supervisors by the end of 2006.

2.5 Maintenance of long-term data collection and equipment. This activity was successfully carried out. All hydrological and climatic data was collected as per the already established protocol, and database records updated accordingly. The data has been used for studying the climatic trends in the watershed and as input to hydrologic model development and calibration.

Data loggers and automated tipping bucket rain gauges were installed to capture the spatial and temporal variability of climate data in three segments of the watershed: 1) at Sigaon Primary School (Upper watershed); 2) at Egerton University (Middle reaches); and 3) at KWS mini weather station for the lower reaches.

Activity 3. Integrating research findings with stakeholders to enhance long-term sustainability and re-align research priorities.

Problem Statement and Approach. The SUMAWA project is an action-research project whose aim is to have all stakeholders within the watershed participate in addressing the challenges they are facing as consumers and guardians of resources within the watershed. Thus, the project has been designed to embed stakeholder concerns into the biophysical research, and for the research findings to be availed to all interested stakeholders. To achieve this interaction six Participatory Rural Appraisals have been conducted throughout the watershed, as well as a stakeholders meeting, women leaders’ forum, and in-house scientific sharing and training workshops for all the leaders from the initially identified six zones and all the interested stakeholders of the watershed. The formation of a genderized River Njoro Riparian Management committee known as the River Njoro Water Users Association (RN-WUA) was the climax of the process with representation from all the zones within the watershed.

Progress.

3.1 Information dissemination and linkages to other groups. Initial outreach efforts put forth by project members were through personal communication and professional contacts. Although this has achieved its own successes, for sustainable and long-term objectives we have undertaken a more institutionalized approach. Towards this effect, the Project has signed two memorandums of understanding (MOUs) with the Water Resources Management Authority (WRMA) and the Nakuru District Health Management Team (DHMT). Although these MOUs are tailored to meet certain objectives, their presence is a clear indication of Project influence over regional policies.

The strategy behind the MOU signed with the WRMA was to mobilize communities within the watershed to form a water users’ association. A series of preparatory meetings were organized, culminating with a 4-day workshop for watershed stakeholders (this workshop is reported later in the report). The

result of these efforts was the formation of the Njoro River- Water Resources Users Association (RN-WRUA). The RN-WRUA now serves as the entry point to the watershed communities, and has strong and formalized ties to the SUMAWA project and WRMA. Furthermore, this body enables other interested parties who have interest in the welfare of the watershed to use the association as an entry point to the communities. We have effectively used the association to arrange for visits of our visitors, identification of on-farm research sites, scouting and “cleaning” the river, and above all introduction of interventions, such as tree seedlings nurseries, planting trees, demarcation of riparian zones, livestock water troughs, bio-sand water filters, and advocacy for better watershed health.

Poor water quality has a high correlation with water borne diseases. For this reason among others we had to partner with the DHMT. As long term plans for improved water quality and quantity are underway by watershed parties, there remains a need for a stop-gap solution on water quality. To address this immediate need, the project has trials underway on bio-sand filters at University of California, Davis and Egerton University. These filters will be migrated from the bench-testing phase to the use in households with high risk for diarrhea diseases to test their efficacy. This activity relies heavily on the relationship and communication established through the MOU and good-faith efforts in data sharing and leveraged efforts.

Telltale billboards have been placed at watering sites warning people on the quality of water. These signs post clear health warnings in 3 languages related to the risks to human health (Figure

3). Other advisory boards are planned on the improvement of the watershed health. Boards are in English and Kiswahili, and in local languages where appropriate.

3.2 Research / Stakeholder conference. This activity was not undertaken as originally envisioned in the project work plan. Efforts related to the formation of the RN-WRUA and associated workshops and training efforts were more significant than

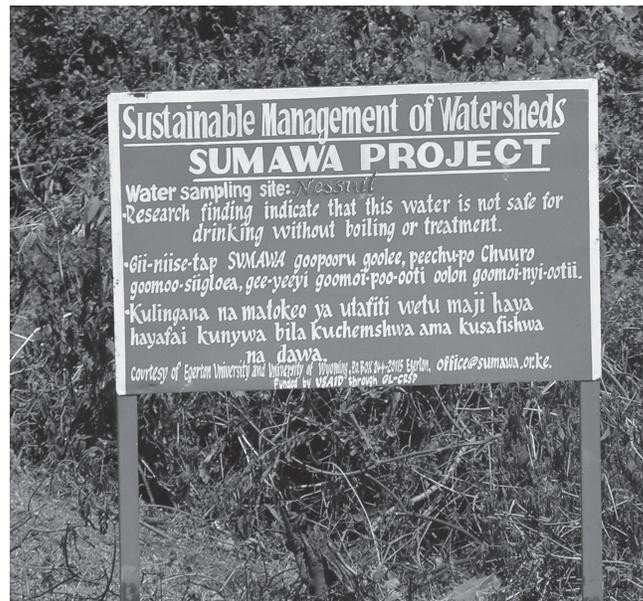
had been anticipated. Human resources and budgets were redirected to ensure that the watershed association linkages were sound at the expense of a formal conference. A 5-day Workshop was the primary substitute for this effort, entitled “Proceedings Towards Formation of Water Resources Users’ Association (WRUA), Sharing Workshop at Saint Mary’s Pastoral Centre Nakuru from 31st May to 4th June 2006”. At this

workshop SUMAWA scientists presented their research findings to community members, who in turn presented and discussed their primary concerns related to the watershed, and their expected goals for the RN-WRUA. A report on the workshop was generated, and serves as a template for the scientific and outreach exchange among project personnel and the community members of the RN-WRUA.

3.3 Perception measurements and longitudinal visits: Problem Statement and Approach. This activity was targeted to document the River Njoro Water Resource Users Association (WRUA) perceptions regarding the watershed both before and after the training. This was achieved by administration of a questionnaire to all the participants that was later analyzed using the Statistical Package for Social Sciences (SPSS).

Progress. Most respondents were able to recognize

Figure 3. SUMAWA sign describing risks to human health



the different sources of pollution in the river, compared to earlier perceptions where they pointed a finger at a particular polluter. Furthermore, the participants were quick to appreciate that the watershed's health can be restored by concerted efforts of all the stakeholders. They were able to identify the primary stakeholders (the community living along the River Njoro) as the main polluters of the river, and expected them to lead the action-oriented efforts to conserve the watershed. In particular, the participants identified the WRUA as a potential force to mobilize the whole community over the conservation issue. The participants identified the actions they anticipated to undertake in order to restore the watershed and have also listed the accrued benefits to these actions.

Activity 4. Evaluation of alternatives to current watershed management, and potential benefits and costs.

Problem Statement and Approach. Decisions made at the household, community, watershed or regional scales are effectively determined on the basis of trade-offs. Choices are selected on the basis of both perceived and actual costs and benefits, and long-term beneficial or deleterious outcomes are determining factors. This activity was designed to gauge both the real outcomes of management strategies (in coordination with the field research activities; Activity 2) and to further develop reasonable scenarios for input to conceptual and mathematical models (Activity 1), so as to provide materials for stakeholders and policy makers interpreting and understanding outcomes of decisions (Activity 3).

Progress.

4.1 Understanding the role and impacts of land cover classification error on spatial modeling efforts in the watershed. This activity was aimed at improving the error understanding in classified remotely sensed imagery by using a modified Monte Carlo technique to propagate random classification errors through a hydrologic simulation model using a Geographic Information System (GIS). Land cover data derived from Landsat imagery is a critical

input to the hydrologic, ecologic, and economic tools used in this project. Errors in spatial data that serve as inputs coupled with uncertainty in landscape propagate through the modeling process. Such error and uncertainty potentially undermines the usefulness of model results. Confusion matrices are standard outputs generated during land cover classification accuracy assessment. These matrices indicate informational classes and likelihood of error for each informational class within a classified image. An analysis of error placement on simulated runoff and erosion will improve model architecture by accounting for error.

A Landsat scene (Path 169, Row 60) acquired on 04 February 2003 was selected for this study. This date corresponds to pre green-up periods and was chosen to capitalize on pronounced differences in reflectance between forested and non-forested areas, decreasing confusion at forest edges between dense forest vegetation and small-scale agricultural plots. Seven thematic classes, excluding shadow and cloud cover, were identified as relevant for quantifying the range of vegetation types and associated transitions across space and time. These thematic classes represent coarse data aggregates corresponding to basic land management practices occurring within the River Njoro watershed. A combination of unsupervised and supervised image classification methods were used to digitally classify the pixels in all three Landsat images (see 2004-2005 report for details on this procedure). The ArcGIS software package was used to generate 100 alternate land cover maps based on the probability distribution of error reported in the error matrix developed from the accuracy assessment. The hydrologic model SWAT was parameterized and run using these 100 alternate land cover maps with all other data elements remaining the same for subsequent model runs. SWAT outputs were compared in a GIS at the sub watershed level to discover how random error placed in the classified imagery would ultimately affect runoff entering the main channel.

SWAT visualizations indicated that in areas where forests were flipped to agriculture, the increase in runoff to the main channel was pronounced, and in many instances more than doubled (Figure 4). Of even greater interest, however, was that final

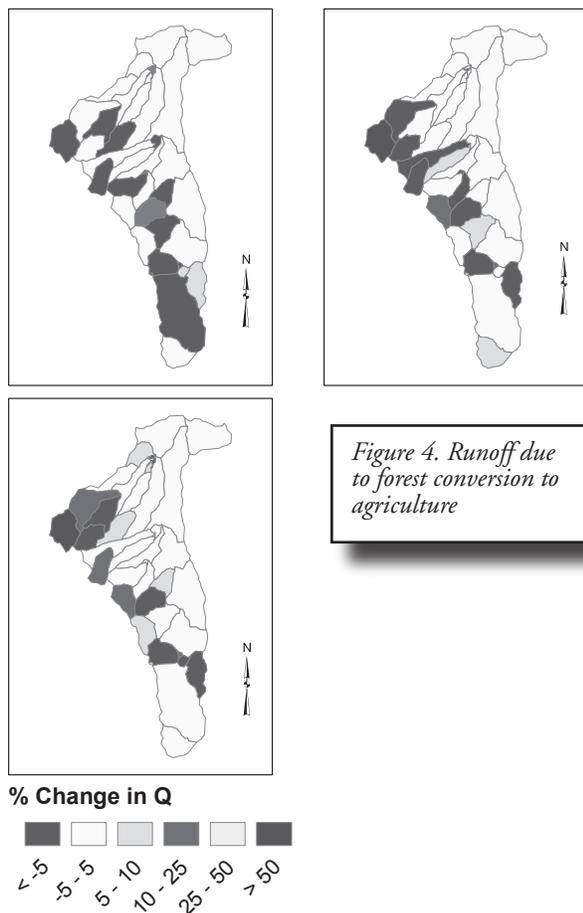
discharge measured at the watershed outlet remained similar among the different model runs. Results from the 100 SWAT realizations indicate that it will be most crucial to incorporate further rules to determine smart error placement as opposed to random error placement; in particular, areas that are most likely to be incorrectly classified (such as edges) versus areas that are unlikely to be misclassified (such as large blocks of contiguous forests). While this study indicated the overall effects of misclassification, it did not directly indicate areas in the watershed that are most vulnerable to degradation. Steps beyond identifying compensating errors are now necessary.

4.2 Understand and interpret the factors leading to adoption of conservation or alternative management practices. The subject of this research is focused on understanding the relationship of determinant factors (social, economic, biophysical, and human perception), and the effect they have on individual farmers' decision-making processes. This research

is rooted in innovation-adoption theory and has ramifications for watershed planners, policy makers, and physical scientists alike. Because land use in the River Njoro watershed is primarily agriculturally based, improving our understanding of why farmers implement conservation practices to protect soil and water resources from erosion, livestock impacts, and degradation of riparian vegetation is of paramount importance for the improvement of water resources.

Extraction activities in previously natural areas have resulted in conversion of large tracts of native and plantation forest lands primarily into small-scale farming (shamba) tracts. This conversion has occurred throughout the middle and upper portion of the watershed from Mukungugu near Egerton University, upstream to Logomon on the main stem, and to Sigaon Primary on the Little Shuru tributary (i.e., to the upper extent of cultivated lands). These recently introduced agricultural activities likely contribute inordinately to a detrimental change in the retention and temporal release characteristics of water resources, and to increased sedimentation of the main stem River Njoro. Increased populations, soil tillage for growing agricultural crops, and year-round livestock keeping have increased pressure on soil resources via less than optimal farming practices, grazing pressure on increasingly limited pasture, increased pressure on riparian zone vegetation, and stream bank trampling and destabilization. Thus, our understanding of the connectivity and relationships between agricultural systems and SWCBs to riverine/riparian ecosystems is vital for developing a reliable and effective watershed management plan.

Over the past 10 months, a doctoral candidate at Utah State University has been responsible for focusing on "Riparian Farmers," classified as small-scale farms located within 500m of the River Njoro and its major tributaries. Background data collection, successful completion of a pilot study in the Barut community, and completion of a household survey throughout the upper and middle portions of the watershed were completed. Two hundred and twenty two households in total were surveyed during the months of August and September, 2006. Data entry and QA/QC of data was performed concurrently and completed 23 September. Data cleaning was



completed during the two-week period following conclusion of the household survey. Data analysis and synthesis of finding is currently underway, and it is anticipated that this phase of the research will be completed by April 2007.

4.3 Human Health Research – Drinking Water Quality Improvement through POU Treatment. Activities and achievements in this area during the past year have focused on understanding the extent and magnitude of fecal surface water pollution in the River Njoro and exploring potential sources, with attention to contributions from livestock and in particular cattle, and addressing stakeholder priorities for clean safe drinking water through identification, adaptation and testing of low cost alternative point-of-water treatment options for households at high risk for water-borne diseases in the Njoro watershed (see Table 1).

Twelve months of surface water fecal pollution monitoring at 15 sites along the River Njoro from the uppermost reaches above settlements to just before the boundary to Lake Nakuru National Park was completed this year. Table 1 reports the averaged results from an initial intensive sampling of 38 sites, but community and section. Where water borne diseases are most prevalent and the burden of disease highest, as indicated by childhood diarrhea prevalence, is among rural agricultural households and communities located above Egerton University

who lack access to improved water supply sources. These dispersed households are obliged to collect water directly from the river for their drinking and household water needs. While peri-urban households in the middle and lower sections of the watershed have improved water supply sources to choose from, these infrastructure are sometimes unavailable, shut-down, too expensive, or scarce relative to demands. Thus, while these households are much less likely to use river water for drinking, choosing to purchase safer supplies, they often supply the bulk of their other household water needs from river water, which is free.

Through participatory rural appraisal (PRA), watershed communities have identified water-borne diseases due to consumption of polluted river water and water scarcity among their top three priority problems. Decentralized approaches to improved water supply may be both more environmentally sustainable and operationally feasible than centralized systems in rural areas of developing countries. Among these, point of use (POU) drinking water treatment (or household water treatment) is receiving increasing attention as a way to rapidly and affordably improve water quality and health for the 1.1 billion people living in developing countries who lack access to a safe water supply, and for additional populations who may have improved supplies but for which quality is unsafe.

Table 1. *Fecal Coliform Counts and Household Characteristics in the Njoro Watershed*

Zone and Communities	Fecal Coliform Counts / 100 ml (Oct 2005)	Child Diarrhea 2-week prevalence (June 2004)	Water Supply & Sanitation Conditions
1. Nessuit	1555 (480-6400)	19%	No improved water supplies; 35% no latrine, poverty highest
2. Mwigito, Njokenia	4533 (2533-7200)	15%	Limited availability of improved supplies; 98% have latrine or toilet.
3. Njora Town, Rumwe	6017 (3400-8800)	13%	Improved supplies available but cost a barrier, improved sanitation.
4. Ngala	1318 (600-2720)	data missing	Improved supplies available but cost a barrier, improved sanitation.
5. Baruti, Kaptembwa	18,714 (3900-41,600)	11%	Improved supplies available but cost a barrier, improved sanitation; higher incomes and greatest employment opportunity.

A variety of POU methods have emerged as promising low-cost options for poor households in developing countries. The most appropriate, acceptable and feasible POU method varies with the large variety of situations that may be encountered in less developed countries, and must be tested, adapted, and promoted on the basis of locally satisfying water safety issues, cultural issues, cost issues, and water demand (volume) issues.

Considerations that must be taken into account when choosing an appropriate POU household drinking water treatment system for a particular developing country community context and setting include water quality, as well as non-water quality issues affecting effective treatment regime. A literature review has been undertaken of the common POU drinking water treatment options now being piloted and promoted internationally include: 1) filters (including biosand filters, ceramic filters and filters made from other locally available materials like burned rice husks or cloth); 2) chemical disinfection (including chlorine, generally in the form of sodium hypochlorite); 3) solar disinfection (SODIS) or disinfection by ultraviolet (UV) light; 4) bone-char filters; and 5) more “advanced” treatment methods such as reverse osmosis membranes that are used in homes in places like the United States. Review of evidence and of pilot testing and evaluation indicates each of these treatment techniques has advantages and disadvantages for appropriately treating drinking water in different settings.

After screening the literature, the biosand filter and chlorine were identified for further testing with the high-risk communities within the Njoro watershed. These POU units were selected to encompass the range of POU technologies available with special attention to extremely low cost, potential for local availability, and sustainability within the Njoro watershed. Unique reasons for selecting the biosand filter and chlorine were materials available locally to produce them or to purchase key inputs; effective removal of pathogenic organisms; and formation of a residual in the case of chlorine, respectively. Candle filters are also potentially appropriate for better off households, due to higher capital and recurring costs associated with regular candle replacement, and have been extensively tested

elsewhere. PUR was not to be explored further because of monetary constraints and availability. River Njoro water tends to be high in turbidity, thus SODIS was not a viable POU option.

Local public health technicians have been engaged to identify high-risk communities, communities with high diarrhea rates among children under the age of five. As a result of early engagement on these health issues with the Nakuru District Ministry of Health staff and director, the SUMAWA project has succeeded in gaining substantial commitments to this work in the form of dedicated three full-time public health technicians for the coming year to support the local testing, behavioral trials, and outreach and promotion of POU methods. This support has been formalized in a Memorandum of Understanding between the MoH, Nakuru District (DHMT) and the SUMAWA project.

Preliminary lab testing of BSF technology, experimental adaptation to local conditions taking into account sand characteristics and hydraulic loading rates has been conducted with leveraged funding at UC Davis this past year. Significant results regarding adjustments to sand processing and filter operation were identified to improve the variability of the treatment performance of the biological systems. Extended and confirmatory testing of results obtained at UC Davis in the lab is start this Fall 2006 at Egerton University in collaboration with the Civil and Environmental Engineering Department, and with the Public Health Technicians of the MOH.

Finally, experimental work to test the usefulness of new microbial source tracking methods based on genetic markers was conducted this past year in the Njoro watershed to identify if existing genetic probes for cattle versus human and other sources of fecal pollution could be identified. Control and river water samples were collected and processed in Fall 2006, and have been analyzed in the lab. Preliminary lab measurements indicate that these new genetic methods may have potential and promise for quantifying the contributing sources of fecal pollution in order to make more effective management decisions in controlling environmental pollution sources and public health risks from infectious fecal -borne pathogens for both humans

Table 2. Economic Activities by Gender

Main Economic Activity	Gender of the Respondent		Total
	Male	Female	
Crops Production	100	133	233
Livestock Production	17	15	32
Selling Timber	2	0	2
Vending food crops	1	6	7
Vending livestock	0	1	1
Formal employment	12	19	31
Casual employment	11	10	21
Running a kiosk/shop	7	9	16

and livestock. Further processing and analysis of laboratory results and their interpretation is planned for the coming year.

4.4 Quantify and interpret economics trade-offs and potential linkages to biophysical and stakeholder outcomes: Problem Statement and Approach. A major stumbling block in this activity remains the difficulty in effectively cleaning and managing the large-scale household data collected in previous years.

Progress. A concerted effort was made in the past year to finalize the data cleaning effort with a thorough revisiting of the issue and a large-scale data re-entry and follow up error checking procedure. Following from recommendations after the error checking of the original data set in early 2005, the entire data set was re-entered during late 2005 and early 2006.

Central to this effort was the amalgamation of separate data sets into a single “master” data set – amalgamation was required because there had been three people working on data entry and each of their data sets had to be reconciled to make a single complete data set. This task was completed in April 2006, and a copy of the resulting data was sent to researchers in both the US and Kenya. A coded questionnaire was developed (i.e. post coded) to help students and faculty navigate around the new data set. A “final” version of the new codebook was created,

although it remains likely that as additional data cleaning continues, minor alterations and updates will be needed to this document. Preliminary analyses from these data sets have focused on data assessment and descriptive statistics. For example, Table 2 shows the dominant economic activities broken down by gender. These data provide a window into preliminary gender-based assessment of strategic interventions that will be important for the successful adoption of planned interventions.

Additional secondary data sources have been identified and acquired to supplement the household data sets. The Njoro agricultural field office has supplied the SUMAWA project with agricultural input and output quantities for many areas of the Njoro watershed. The project has contracted with these officers to supply these data to us.

Due to the considerable efforts and delays associated with cleaning and managing the available data, the anticipated economic modeling efforts were placed on hold as personnel and budgetary resources were redirected. Econometric and simulation models for 2005 for the Machakos region have been acquired and may serve as templates for future research in this area. Current efforts are focused on identifying areas of commonality/differences between those models and those likely needed for the Njoro region.

GENDER

Gender activities in the SUMAWA project are focused on 3 levels. The first level is the inclusion and significant participation of women in the project. Of the 8 PhD-holding research scientists on this project, 3 are women. In the past year we made a strategic decision to include the Gender and Mainstreaming Specialist (Dr. Lois Chiuri) in all management meetings and provide her with a full voting right on project management decisions as a way to ensure that the role and importance of gender was given prominent status and management authority in the project. In addition, there are several women holding positions of responsibility in research, and acting as graduate students. SUMAWA is committed to identifying and recruiting capable women, especially in areas that are historically under-represented. For example, women are in leadership

roles (co-PI status) in engineering and economics, fields in which women are under-represented. In addition, a female PhD graduate student at the University of Wyoming is pursuing her degree in the realm of GIS and uncertainty modeling, while a PhD student at UC-Davis is working on her degree in engineering and human health. Gender equity at the student level is a focus of the team, and to date we have had two female Kenya graduate students work on the project, and are actively seeking women for the coming project years.

The second level of gender activities concerns the collection and analysis of field data. In the last year SUMAWA team collected sex-disaggregated data. In the coming year analyses will continue related to gender roles and the identification of sex-based economic opportunities or barriers. SUMAWA research findings show that women in the River Njoro Watershed are centrally responsible for domestic water supplies, family health and hygiene, firewood collection, and carry out important roles in both farm and non-farm household income production activities that have implications for the sustainability of watershed resources. Furthermore, a larger portion of poorer households in rural and urban areas tends to be women-headed, further illustrating the importance of building gender and sex-based analyses into economic analyses.

The third level of gender activities relates to stakeholder engagement and research linkages in the communities. The SUMAWA project was instrumental in the formation and establishment of the River Njoro Water User Association. During the formation of the Association, it was mandated that each community elect three representatives, including a woman and a young person, so as to ensure that a variety of voices and representative viewpoints were present and accounted for in watershed decision making. Exposure visits and planned outreach activities are constructed so as to encourage the participation of women, and stakeholder training workshops assure that diverse stakeholder interests, perspectives, and impacts, particularly for poor households, are represented in developing interventions and management plans for the watershed.

POLICY

One of the primary research thrusts in this project is stakeholder involvement and outreach. The problems inherent to the Njoro were initiated at the highest levels of government in the form of political favor for support. Thus, the question of public policy involvement is central to understanding the mechanisms controlling land tenure, management, and stewardship. In the past year we established formalized research and outreach Memoranda of Understanding with key policy makers in the watershed: the Water Resources Management Authority (WRMA); and the Nakuru District Health Management Team (DHMT). By linking with WRMA we were able to play a key role in community mobilization to form a water users' association (River Njoro Water User Association; RN-WRUA). The RN-WRUA now serves as the entry point to the watershed communities and has strong and formalized ties to the SUMAWA project and WRMA.

Outreach through personal communication and networking is ongoing in Kenya, and the host country PI and co-PIs as well as the Project Manager have served as science ambassadors to land managers, politicians, and policy makers. Long-term efforts are aimed at establishing professional relationships with policy makers beyond just those in the watershed, including at the National or International level, including NGO's and the Ministry of Water. In the past year, SUMAWA lead scientists (including Drs. Miller, Gichaba, and Shivoga) met with representatives of the locally active NGO's to discuss ways in which formalized relationships can be established. To date, Drs. Shivoga and Semenyé have been particularly active in meeting with interested parties, both at Egerton and in Nairobi.

OUTREACH

The primary point of contact for outreach efforts is the RN-WRUA, which was established to serve as the main point of contact between watershed communities and the scientific and policy actors in the region. Central to the successful implementation of interventions is identifying key stakeholders

and policymakers that are in positions of authority (whether that be moral, ethical, or managerial) and ensuring that they are committed to the success of the proposed intervention. We have been actively involved in providing learning opportunities for local stakeholders and land managers, including hosting a 5-day workshop within the watershed.

A series of billboards have been placed at watering sites along the River Njoro clearly identifying the risks associated with utilizing the river water for consumption due to its poor quality. Other advisory boards are planned on the improvement of the watershed health. These boards are in English and Kiswahili, and in the local language where appropriate.

DEVELOPMENTAL IMPACT

Environmental impact and relevance. There are two identifiable indicators we are using in the pursuit of the overall objectives of SUMAWA: (1) a research goal to improve the understanding of biophysical and social dynamics governing watershed health in rural areas; and (2) a development goal to improve the health of threatened/degraded upland watershed systems in East Africa on a productive and sustainable basis. The Njoro watershed system is fragile and has direct impacts on the ecological integrity of Lake Nakuru, a RAMSAR wetlands site of international importance. The upper reaches of the watershed extend into the forested reaches of the Mau escarpment. These forested areas, which have only recently lost their protected status, provided valuable stability to the ecological and watershed health of the region. The primary biophysical research areas in the SUMAWA project are watershed hydrology and ecology, both of which are focused on quantifying environmental health, and providing information to decision makers in order to maintain proper functioning condition. A suite of environmental models are being developed to better understand the environmental system as a whole. The Njoro watershed will provide a template for integrated multiple objective decision-making in which environmental concerns are weighed in consideration with human-related issues such as economics, human health, and off-site impacts.

Strategies for improved watershed conditions serve as principal intervention options. Examples include agriculture conservation practices, especially on steep slopes, improved riparian conditions for stream buffering, improved agricultural and grazing practices to reduce erosion and improve infiltration and groundwater recharge, and the application of agroforestry practices in sensitive areas.

Agricultural sustainability. One of the most significant concerns regarding the local and future condition of the Njoro watershed is the sustainability of agricultural practices. Evidence suggests that even recent immigrants are concerned with soil sustainability and the future of agriculture in this region. A lack of economic and agricultural system diversity is present in the watershed, which increases the vulnerability of the residents to economic downturns associated with agriculture. A series of sustainable practices, best management practices, and potential alternatives to present cropping systems, have been identified within the watershed and are being investigated for their potential adoption at a larger scale. Examples include agroforestry, soil conservation practices, pond aquaculture, and increased variability in crops, including the reintroduction and harvest of indigenous plants.

Biotechnology. This project does not have any component related to biotechnology.

Contributions to U.S. agriculture. It has long been recognized that water resources and their effective use and management for long-term sustainability are crucial to economic, human health, and environmental stability. This statement applies with equal validity to Kenya and the US. The problems facing residents of the Njoro watershed are undoubtedly more critical than those in developed nations such as the US, but parallels exist nonetheless. For example, the watershed is comprised of a mixture of stakeholders with a variety of complementary and competing interests, including agriculture, livestock grazing, business, residents, and the environment itself. Land cover is rapidly changing due to population pressures and policy decisions with resultant negative off-site impacts. Land managers and policy makers such as the BLM, State Departments of Environmental Quality, the USFS, and the National Park Service,

are charged with managing resources with both a multiple use and sustainable yield mandate, often in locations similar to the Njoro where competing interests create difficulties for the land manager.

The primary potential benefits to the US that will evolve from the SUMAWA project surround contributions in knowledge to U.S. agricultural systems. Management of landscapes, including rural areas in the United States has been shifting to a watershed-based approach. Land management agencies, including the US-EPA, NRCS, and BLM are moving resources and quantitative tools to the watershed scale in order to comply with both Federal regulations and to maintain a strong scientific footing in terms of understanding upstream-and downstream linkages in environmental health.

Contributions to host country. The Njoro watershed has been established as an experimental watershed with the addition of continuous monitoring stations for rainfall and runoff. These monitoring stations provide the means to use cutting-edge tools and models for scientific assessment and land management. There is a significant training component for Kenyan students and researchers and we recognize and maintain that successfully training students in integrated and sustainable research and decision-making will be beneficial to Kenya. An integrated decision support tool will be developed that will describe the processes governing watershed health and response to changes in land management and tenure. These tools will provide a scientific basis to interested parties, such as land managers, policy makers, and local residents interested in understanding their physical environment.

A series of interventions for the improvement of economic stability, ecologic health and hydrologic resources are planned. These interventions include demonstration plots for pond aquaculture, agroforestry, alternative agricultural practices, and water distribution. It is anticipated that these interventions will have a localized beneficial impact. An outreach component will be implemented that links local landowners to the planned interventions so as to facilitate their adoption on other regions of the watershed that would have a larger-scale impact on watershed health. A school-based outreach and education component will introduce schoolchildren

to land stewardship and environmental awareness.

Linkages and networking. The SUMAWA team has formally enjoined the Rift Valley Water Resource Management Authority, the River Njoro Water User Association, and the Nakuru District Health Management Team as collaborative partners. Memoranda of Understanding have been signed in order to cultivate long-term working relationships. The SUMAWA team has built local community linkages through the process of stakeholder engagement (PRA), and will serve as a link between the Authority, researchers, and community leaders to aid in the creation of the watershed user's group with the goal of enhancing both local knowledge and management of their system for long-term sustainability under the newly emergent Kenya law.

Collaboration with international research centers (IARCS) and other CRSPs. The SUMAWA project was initially founded through a joint effort with the Aquaculture and Global Livestock CRSPs. The formal agreement with the A-CRSP has not been maintained, but members of the research team are active with the CRSP and we have incorporated pond aquaculture into the project as a potential intervention for enhanced income and a component of the sustainable development plan. Fish demonstration ponds at Egerton University affiliated with the project attract visitors from and outside Nakuru District. The visitors are brought by Kenya Fisheries Department officers, who use the ponds for outreach and extension purposes.

In addition, a formal agreement with the Trade-off project led by John Antle and funded by the Soil CRSP is a direct outcome of the activities of the previous year. Future research directly builds on this relationship and project outcomes and activities are tied directly to the collaborative effort with this project.

OTHER CONTRIBUTIONS

Support for free markets and broad-based economic growth. Research and development as approached by the SUMAWA team is directly targeted to account for the significant and cornerstone role agriculture plays in Kenya's prospects for long-

term economic stability and sustainability. We are working with local agencies and community groups to create a comprehensive watershed plan in support of sustainable development. While the upper portion of the watershed lacks an agribusiness sector, the lower sections of the watershed are dominated by larger farms and trend towards a more urban setting; in the coming year we are targeting a better understanding of and linkage with these groups. Private enterprise and access to markets are key components of our economic development and sustainability modeling efforts. It has been clearly recognized that access to free markets and a market-driven economy with effective techniques for responding to macro-scale economic forcing is extremely supportive of rural economic development, and is a constraint in the Njoro watershed. Economic analyses and stakeholder engagement in the successful adoption of effective land management and farming practices are core constituents of our integrated modeling and decision support framework.

Contributions to and compliance with Mission objectives. The SUMAWA project is directly in line with the primary USAID/Kenya natural resources program objective, which is to prevent unsustainable natural resource management and enhance conservation. Our focus influencing change through integrated science and stakeholder engagement is aligned with the Mission's approach. The Mission supports initiatives aimed at natural resource management with a focus on activities that are included in the SUMAWA scope of work, including watershed management, soil conservation, and agroforestry. The SUMAWA goals are also in line with the Mission's agriculture support objective, which promotes enhanced stakeholder dialogue and outreach for improved agricultural production.

Concern for individuals. This project is aimed primarily at improving watershed condition through stakeholder interactions. These stakeholders comprise multiple tiers of scale and influence, from land managers to business owners and the individual landowner. Interventions planned in this project are concerned with improving livelihoods and directly benefiting residents. The structure of the stakeholder engagement is specifically designed to facilitate and understand rationale behind decision-making at the

household scale.

Support for democracy. One of the essential components of a free and democratic society is an informed public. Individuals, communities and institutions should be aware of governance and decision making that impacts their lives. More importantly, people should be empowered with an opportunity to make themselves heard and participate in the decision-making process. This project contains these essential ingredients, as we are disseminating both research findings and policy acts that govern watershed dynamics directly to resident stakeholders. We have an education and outreach component operating in the local school system as a mechanism for increasing education, awareness, and participation.

Humanitarian assistance. Humanitarian assistance need not be solely restricted to immediate distribution of aid. In our case, we are providing assistance in the form of information exchange and suggestions for improving livelihoods. These suggestions are intended to enhance human health, economic condition, and reduce the exposure and risk of watershed residents to seasonal and political fluctuations. These approaches are designed to reduce long-term negative impacts and reduce rural poverty.

LEVERAGED FUNDS AND LINKED PROJECTS

The total value for leveraged funds for the SUMAWA project during 2006 was \$68,060. The sources of those funds were as follows:

Jim Ellis Mentorship Program for Graduate Students, Development and Trial of Point-of-Use Treatment Systems to Improve Drinking Water Quality in High Risk Communities of the River Njoro Watershed, Kenya, 10/2005-9/2006, \$2,980.

Niels Riegel, water resources modeling capacity building and WEAP21 training, 5/2006-7/2006, \$22,000.

UC Davis Department of Civil and Environmental Engineering, undergraduate student engineering laboratory assistance with POU experimental testing, 4/2006-9/2006, \$3,500.

UC Davis Department of Civil and Environmental Engineering, graduate student support for S. Tiwari, 10/2005-5/2006, \$5,000.

UC Davis Department of Civil and Environmental Engineering, laboratory supplies, equipment, and materials for POU experimental lab testing and research, 1/2006-9/2006, \$7,000.

Granite Construction, donation of sand for BSF filter manufacture and testing, Spring 2006, \$150.

City of West Sacramento Water Supply Treatment Plant, loan of equipment and technical assistance with collection, transport, and storage of raw Sacramento River water for POU experimental lab testing and research, 4/2006-9/2006, \$350.

Ministry of Health-Nakuru District, contribution of 3 public health technicians' salary and benefits, 10/2005-9/2006, \$2,800.

University of Wyoming Graduate School, linkage with high school teaching, 9/2006, \$4,280.

NASA Space Grand Consortium, Univ. of Wyoming, graduate student support for T. Baldyga, 10/2005-5/2006, \$20,000.

University of Wyoming Graduate School, graduate student support for T. Baldyga, 6/2006-9/2006, \$500.

Huckett, Stephen. American, M, Utah State University, Forest, Range, and Wildlife Sciences, PhD.

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Ogalleh, Sarah. Kenyan, F, Egerton University, PRA-Stakeholder, MS.

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Ngugi, Milka. Kenyan, F, Egerton University, Ecology, MS.

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Zollinger, Ashley. American, F, UC Davis, Civil Engineering, BS.

Lorente, Mario. American, M, UC Davis, Microbiology, PhD.

TRAINING

Degree Training

Completed

Bett, Eric. Kenyan, M, Egerton University, Agricultural Economics, MSc.

Kiragu, Joseph. Kenyan, M, Egerton University, Environmental Science, MSc.

Mainuri, Gichuru. Kenyan, M, Egerton University, Geography, MSc.

Njeri, Mary. Kenyan, M, Egerton University, Food and Science Technology, MSc.

In Progress

Baldyga, Tracy. American, F, University of Wyoming, Rangeland Ecology & Watershed Management, PhD.

Non-Degree Training

Bio Sand Filter Construction Training, September 20-26, 2006. Attended by 8 participants (7 male and 1 female).

Seminar entitled: Drinking Water Quality Improvement, September 20, 2006 at Egerton University. Facilitated by Ms. Sangam Tiwari. Attended by 15 participants (11 male and 4 female).

Awareness and Leadership Workshop Towards Formation of River Njoro, May 31, 2006-June 4, 2006. Attended by 64 participants (49 male and 15 female).

GIS and DATA Management Training, January

10-12, 2006 at Gate House in Nakuru. Attended by 13 participants (9 male and 4 females).

Workshop on Water Evaluation and Planning Model (WEAP) by Eng. Niels Riegels and Dr. Marion Jenkins, May 18, 2006 at Egerton University. Attended by 23 participants (19 male and 4 female).

Water Evaluation and Planning Model (WEAP) Training by Eng. Niels Riegels, held weekly from late march through mid June 2006, for 10 weeks at ERMIS Africa in Nakuru and at Egerton University. Attended by 10 participants (9 male and 1 female).

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PUBLICATIONS

Manuscripts and Reports

Baldyga, T.J., S.N. Miller, K.L. Driese, R. Sivanpillai, and C. Maina Gichaba, 2005. Enhanced land cover classification in a tropical Kenya landscape. Proceedings of Pecora 16: "Global Priorities in land Remote Sensing". October 23-27, 2005, Sioux Falls, SD.

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Krupnik, T. M.W. Jenkins, S. Mooney, and E.K. Bett, (in press). "Net Present Value Analysis to Assess the Economic Consequences of Changing Farming Systems in the Upper Catchment of the River Njoro Watershed". Peer-reviewed paper accepted to the Tenth Biennial Scientific Conference & Agricultural Forum, Kenya Agricultural Research Institute. 12 – 17 November 2006, Nairobi, Kenya

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Milkah, F.N., W. A. Shivoga, Mucai Muchiri and S. N. Miller, 2005. Effects of Land Use Changes on Birds Composition along River Njoro: A Watershed of Lake Nakuru. Proceedings of the 11th International Conference on the Conservation and Management of Lakes, 31 October to 4 November 2005, Nairobi, Kenya. Volume II: 540-544.

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change on watershed hydrology. Proceedings of the AWRA Conference on Geographic Information Systems (GIS) and Water Resources IV, Houston, Texas, May 8-10, 2006.

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Riegels, N., 2006. "Surface water hydrology development for WEAP Njoro Model" Technical Memorandum to WEAP Njoro Modeling Team, SUMAWA Project. 21 June 2006. (Final)

Shivoga, W.A., M. Muchiri, S. Kibichi, J. Odanga, S.N. Miller, T.J. Baldyga, C. Maina Gichaba, 2005. Impacts of upland land use on downstream water quality in River Njoro Watershed, Kenya. Proceedings of the 11th International Conference on the Conservation and Management of Lakes, 31 October to 4 November 2005, Nairobi, Kenya. Volume II: 472-476.

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Bett, K. E. 2006. Socio-economic and Biophysical Factors Influencing Land Use: A Case Study of River Njoro Watershed, Nakuru District, Kenya. Ms Thesis Egerton University, Kenya.

Kiragu, J. M. 2005. Trends. Local Perceptions and cost of waterborne Diseases in River Njoro watershed, Nakuru District. Ms Thesis Egerton University, Kenya.

Krupnik, T.J. 2006, Linking Farmer, Forest and Watershed: Agricultural Systems and Natural Resources Management Along the Upper Njoro River, Kenya. University of California International and Area Studies Digital Collection, Article #3. <http://repositories.cdlib.org/uciaspubs/articles/3>

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within the River Njoro Watershed Kenya. Ms Thesis Egerton University.

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ABSTRACTS AND PRESENTATIONS

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Okelo, M.O., J.O. Onyando, W.A. Shivoga and S. N. Miller, 2005. Analysis of Surface Runoff and Soil Loss under different Land Use Types in River Njoro Watershed Using a mini Rainfall Simulator. Presentation at the 11th International Conference on the Conservation and Management of Lakes, 31 October to 4 November 2005, Nairobi, Kenya.

Shivoga, W.A., M. Muchiri, S. Kibichi, J. Odanga, S.N. Miller, T.J. Baldyga, C. Maina Gichaba, 2005. Impacts of upland land use on downstream water quality in River Njoro Watershed, Kenya. Presentation at the 11th International Conference on the Conservation and Management of Lakes, 31 October to 4 November 2005, Nairobi, Kenya.

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**DEVELOPING INSTITUTIONS AND CAPACITY FOR SHEEP
AND FIBER MARKETING IN CENTRAL ASIA (WOOL)**

NARRATIVE SUMMARY

The project involves four activities that are being carried out in four regions of Kazakhstan and Kyrgyzstan. The year's research was the last year of the three-year sequence of planned project activities.

The rural populations of Kazakhstan and Kyrgyzstan experienced dramatic decreases in living standards after the collapse of the Soviet Union, and have yet to recover. Poverty levels have risen, life expectancy has decreased, and infant mortality has increased. With the simultaneous deterioration of non-farm employment opportunities, strategies for poverty reduction and improvement of living standards for rural populations depend heavily on increasing food security and income from agricultural and livestock activities (World Bank 2001). The livestock sector is being reconstituted along market-led lines following the dramatic crash in sheep numbers during the early 1990s. Recent changes in the world markets for wool and other animal fibers have encouraged producers of sheep, goats and other fiber-bearing animals in Central Asia to seek innovations and developments, which will improve their livelihoods through more income from animals.

The goal of the project is to collaborate with wool and cashmere producers, buyers, and processors in Kazakhstan and Kyrgyzstan to improve the marketing process and infrastructure and increase fiber quality and value. Currently, numerous deficiencies in the production and marketing system lower the quality and value of wool and cashmere, and prevent Central Asian producers from competing in the domestic, regional, and international market. The marketing problems identified in the course of our research include poor fiber preparation and sorting at farm

level, poor sorting, testing, and quality assessment of wool and cashmere by middlemen buyers, lack of objective laboratory testing and reliable market information on the quality of wool and cashmere, and lack of connections of producers to global markets. The project activities were designed to address these deficiencies by: 1) training wool and cashmere producers in preparing and sorting fibers prior to marketing to increase quality and value; 2) training middlemen buyers in wool sorting and quality assessment; 3) collecting wool and cashmere samples, testing them using contemporary Australian-made equipment, and sharing the test results with producers, buyers, and researchers; 4) informing local and international wool and cashmere buyers about the quality and quantity of fibers produced in Kazakhstan and Kyrgyzstan to increase competition and prices; and 5) informing Central Asian producers and buyers about the organization, quality standards, prices, and trends on the global wool market.

Market development in this context is not a one-dimensional economic problem, but has social and institutional aspects, which make producers cautious about risk. Most small-scale producers rely on their flocks to meet part of household food requirements, which influences their decisions about breed selection and sales. Households often consist of multi-generation extended families that share assets and responsibilities, while social insurance provision is extremely limited. Many sheep and goat producers live in geographically remote locations and are poorly served by transportation infrastructure, extension and veterinary services, financial services, and communications. Although the region's pastoral traditions are centuries old, most contemporary

producers' experience was formed under Soviet production and distribution systems, which were not based on subsistence or market logic, and in which a few specialists managed most skilled tasks. For these reasons developed country marketing arrangements and assumptions cannot be uncritically imported, or expected to result in immediate adoption. Solutions call for adaptive research and trialing that can demonstrate benefits without increasing risks or requiring additional liquidity from producers.

RESEARCH

Activity 1: Promoting Market Competitiveness in the Fiber Pipeline

Problem Statement and Approach. Previous work suggests that producers can receive better prices for their fiber by offering better quality and volume to buyers of wool and cashmere. This activity will increase producers' ability to offer the higher quality products demanded by international markets, and increase the flow of market information flows between producers and a broader global commercial sector. Marketing wools and fibers that are more attractive to buyers will have direct development relevance for producers who can expect to receive better prices and larger volume sales for their products, improving incomes. Physical characteristics of fibers, such as average fiber diameter, staple length, color, and yield determine the value of the fiber. Producers should understand these characteristics for the fibers they are producing. Objective measurements that characterize these physical characteristics are an important component allowing the producer to increase his/her ability to effectively market his product and also improve the quality of his product. Preliminary data collected through interviews would provide information on what products are produced and how these products are currently marketed.

Progress.

Wool sample tests on OFDA2000 and OFDA4000 (2003-2006). During the project years 2003-2004 and 2004-2005 the project team worked with farmers, wool buyers and scientists to collect, test and analyze over 7,000 wool samples

from live animals on 39 farms in two key sheep-breeding regions of Kazakhstan, the Dzhambul, and the Almaty region. The data provided the first objective information on the quality of Kazakh wool since the breakdown of the Soviet Union in 1991. In 2005-2006 the team: 1) completed the analysis of wool samples from live animals collected during the first two years of the project; 2) collected and tested 1,560 core samples from wool bales at seven farms and wool collection points; 3) collected and tested 219 samples from live Merino sheep imported from Australia to Kazakhstan in 2005; and 4) analyzed and compared all samples collected during the three years of the project.

1. Analysis of samples collected in 2003-2004 and 2004-2005. During the first two project years over 7,000 samples from live animals were collected and tested to provide objective information on wool quality for farmers, buyers, scientists and processors. In 2004, over 3,000 samples were collected on 38

Sample collection in the Dzhambul oblast. Photo by Liba Brent.





OFDA2000 at the KSBA fiber laboratory. Photo by Liba Brent.

farms in the Almaty region. The Almaty region is the largest sheep-producing region in Kazakhstan. It has around 3 million sheep, or 20% of the 15 million sheep produced in Kazakhstan in 2006. Farms in the Almaty region produce 60% of purebred Merino sheep. In 2005, over 4,000 samples were collected on 39 farms in the Almaty and the Dzhambul regions. The Dzhambul region produces over 2 million sheep, and around 25% of all purebred Merino type sheep. It is the third largest sheep-producing region, after the Almaty and the Southern Kazakh region¹, and the second largest Merino-producing region.

The 2004 samples were tested using OFDA2000 at the fiber laboratory of the Kyrgyz Sheep Breeders Association (KSBA) in Kyrgyzstan. The KSBA laboratory was the only laboratory with contemporary testing equipment in the region at that time.

The 2005 samples were tested at a new laboratory of the ST Group Company that was set up in 2005 and equipped with OFDA4000. The research team and our collaborators from the ST Group Company

planned to compare the OFDA2000 and OFDA4000 test results and assess changes in wool quality on 27 farms that were sampled both years. However, the initial comparative test of 200 samples, conducted on August 29 2005, showed considerable differences between the OFDA2000 and OFDA4000 results. The OFDA4000 measurements showed the average fiber diameter (FD) to be greater by 1.5 micron compared to the OFDA2000 measurements of the same 200 samples (Table 1). The team decided to work on explaining these differences and conduct additional testing during the third year of the project.

During the third year of the project, our collaborators from the ST Group Company fiber laboratory worked with the Australian Company “Interwoollabs” to re-calibrate the OFDA4000. The OFDA was re-calibrated in December 2005, and Assel Imasheva, the director of the wool lab, conducted additional tests of the samples. The results are shown in Table 2.

The results show that after re-calibration, the OFDA4000 test results were comparable to OFDA2000 results. The average fiber diameter measurement decreased by 1.56 micron, and the standard deviation decreased by 1.26 micron. These differences were used to adjust the 2005 test results. The original and adjusted values are shown in Table 3.

1.1 Wool Data by Region. The adjusted 2005 data was organized by region (Table 4) and sheep breed (Table 5).

The regional data shows that Merino farms in the Almaty and Dzhambul oblasts produce wool of relatively similar parameters. The finest wool of 22.29 micron was produced in the Dzhambul oblast on the Merke and the Pioneer farms. Both of the farms are former state breeding farms that breed the Southern Kazakh Merino sheep. The average SD of approximately

Table 1. Differences in testing 200 wool samples at the KSBA fiber laboratory using OFDA2000, and at the ST Group laboratory using OFDA4000, August 2005.

200 Samples	FD OFDA2000	FD OFDA4000	Length OFDA2000	Length OFDA4000
Averages	21.5	23	73.6	77.9
Difference	-1.5	1.5	-4.3	4.3

Table 2. Comparative results of testing unwashed wool samples collected in 2005 on AFDA 4000 before and after recalibration.

Dates of Testing: August 29, 2005, December 27, 2005.											
No	Sample code	FD 8/29	DF 12/27	SD 8/29	SD 12/27	CV 8/29	CV 2/27	CF 8/29	CF 12/27	Curve 8/29	Curve 12/27
31	144	24.81	22.38	6.72	5.18	27.09	23.15	82.65	93.08	101.67	106.36
32	31	27.66	26.19	6.15	5.87	22.33	22.41	69.65	77.19	92.49	88.46
33	197	26.78	24.16	7.71	5.74	28.79	23.76	71.76	86.85	99.79	74.35
34	188	23.93	22.91	7.1	4.3	29.67	18.77	88.82	95.71	122.31	84.85
35	157	26.3	24.45	5.48	4.58	20.84	18.73	80.96	90.17	96.64	92.99
36	181	26.5	24.02	7.17	5.9	27.06	24.56	74.91	86.06	103.22	90.44
37	217	23.07	21.81	6.01	5.33	26.05	24.44	90.3	93.56	115.68	118.47
38	24	22.14	22.26	5.39	4.09	24.35	18.37	95.24	96.75	111.87	115.97
39	37	24.79	23.03	6.23	5.12	25.13	22.23	82	90.74	127.17	112.22
40	160	25.93	25.47	6.99	5.35	26.96	21.01	76.31	82.49	103.88	85.53
41	15	27.51	26.26	6.14	5.26	22.32	20.03	73.58	80.98	120.61	109.69
Average		25.24	23.69	6.36	5.1	25.26	21.42	80.6	85.7	104.15	94.97
Difference			-1.56		-1.26		-3.84		5.10		-9.18

Table 3. Original and adjusted 2005 test results for Kazakh farms.

Dzhambul oblast								
Sample Count	Farm	FD	FD	SD	SD	CF	CF	Length
			ADJ		ADJ		ADJ	
70	Pioneer	23.1	21.54	5.5	4.24	86.5	91.6	87.4
163	Merke	24.6	23.04	6.5	5.24	82.1	87.2	96.3
233	Total	23.85	22.29	6	4.74	84.3	89.4	91.85
Almaty oblast, Aksui Region								
Sample Count	Farm	FD	FD	SD	SD	CF	CF	Length
			ADJ		ADJ		ADJ	
103	Tyrsynbai	25.7	24.14	6.1	4.84	80.7	85.8	69.7
100	Seilkchan	24.4	22.84	5.8	4.53	83.8	88.9	73.9
481	Kopa	23.4	21.84	5.7	4.44	87	92.1	73.6
24	Turturugov	25	23.44	5.8	4.54	83.6	88.7	64.6
104	Bekbolat	25.3	23.74	5.9	4.64	78.9	84	67.4
169	Arai	25.3	23.74	6	4.74	80.4	85.5	95.8
199	Eskeldy	25.2	23.64	6.1	4.84	78.9	84	88.5
122	Myngasarov	24.4	22.84	5.6	4.34	84.5	89.6	89.5
102	Adyn	26.2	24.64	6.2	4.94	77.5	82.6	78.3
174	Karachok	24.8	23.24	6.1	4.84	81.9	87	70.3
256	Almaty	26.1	24.54	6.4	5.09	74	79.1	71.9
20	Sarybulak	27.2	25.64	6.6	5.34	68.6	73.7	98.2
1854	Total	25.3	23.69	6	4.76	80	85	78.5

Table 3 continued: Original and adjusted 2005 test results for Kazakh farms.

Almaty oblast, Dzhambul region								
Sample Count	Farm	FD	FD	SD	SD	CF	CF	Length
			ADJ		ADJ		ADJ	
184	Kurty	23.9	22.34	6.4	5.14	85.4	90.5	83.5
99	Baimukhaev	25.2	23.64	6.4	5.09	80.95	86.05	83.9
40	Kusainov	24.5	22.94	6	4.74	84.5	89.6	81.2
80	Surtaev	25.1	23.54	6	4.74	81.1	86.2	80.9
53	Nurgaliev	26.2	24.64	6.2	4.94	75.6	80.7	83.7
95	Tuleukulov	25.3	23.74	6.2	4.94	82	87.1	81.2
63	Dusembiev	26.7	25.14	6.4	5.14	74.4	79.5	85.7
61	Sarsebaev	27	25.44	6.7	5.44	72.2	77.3	87
95	Fazyl	25.5	23.94	6	4.69	79.75	84.85	84.6
49	Abenov	26.4	24.84	6.3	5.04	75.2	80.3	89.9
819	Total	25.6	24	6.3	4.99	79.1	84.21	84.2
Almaty oblast, Koksui region								
Sample Count	Farm	FD	FD	SD	SD	CF	CF	Length
			ADJ		ADJ		ADJ	
43	Kainar	25.4	23.84	6.1	4.84	80.8	85.9	73.7
20	Zhumagulov	23.6	22.04	5.5	4.24	89	94.1	77.6
47	Bazarbai	24.1	22.54	6.1	4.84	85.3	90.4	69.5
20	Musabek	23.5	21.94	5.9	4.64	88.4	93.5	77.6
116	Alrun	24.7	23.14	6.3	5.04	81.9	87	86.3
246	Total	24.3	22.7	5.98	4.72	85.08	90.18	76.94
Almaty Oblast, Raimbek region								
Sample Count	Farm	FD	FD	SD	SD	CF	CF	Length
			ADJ		ADJ		ADJ	
163	Uzumbulak	24.9	23.34	6.1	4.84	82.2	87.3	80.2
56	Moldesanov	26.4	24.84	6.55	5.29	74.6	79.7	77.2
50	Kumtekei	24.5	22.94	6.5	5.24	81.7	86.8	79.8
143	Rakhmetov	24.6	23.04	6.7	5.44	81.8	86.9	82.9
41	Dauletbakhov	24.3	22.74	6.6	5.34	83.2	88.3	71.7
55	Aldzhanbaev	25.4	23.84	6.4	5.14	78.7	83.8	74.8
74	Nogaibaev	25.9	24.34	6.6	5.34	77.6	82.7	79.8
62	Bakaev	24.8	23.24	6.1	4.84	83.3	88.4	81.9
39	Zhylyesai	26.4	24.84	6.7	5.44	74.5	79.6	89
52	Bukienov	24.7	23.14	6.4	5.14	83.1	88.2	78.3
735	Total	25.19	23.63	6.47	5.21	80.07	85.17	79.56

Table 4: Wool sample test results by region.

Region	# of samples	FD	SD	CF	Length
Dzhambul obl.	233	22.29	4.74	89.4	91.85
Koksui region, Almaty obl.	246	22.7	4.72	90.18	77
Aksui region, Almaty obl.	1854	23.69	4.76	85	78.5
Raimbek region, Almaty obl.	735	23.74	5.21	84.7	79.56
Dzhambul region, Almaty obl.	819	24	4.99	84.21	84.2
TOTAL	3887	23.28	4.88	86.7	82.22

5 micron means that 2/3 of the fibers fall within 22.29 + / - 5 micron (17.29 - 27.29 micron). The SD value of 5 micron is relatively high, especially in comparison with Australian Merino sheep that have SD around 3.5 micron (Table #12). It shows that the Kazakh Merino sheep produce wool that is less consistent than Australian Merino wool. From the processor's viewpoint, this is an undesirable quality that will be discussed later in the report. The remaining farms in the Koksui, Raimbek, Aksui and Dzhambul regions of the Almaty oblast produce wool of relatively similar FD (23-24 micron), and show an SD of nearly 5 micron.

As noted earlier, the Almaty and Dzhambul oblasts are the first and third largest sheep and wool producing regions in Kazakhstan. The Almaty oblast produces nearly 7,000 tons of wool, which is nearly 25% of the 28,500 tons of wool produced in Kazakhstan in 2005. The Dzhambul oblast produces over 4,000 tons, which is 14.5%. About 35% of the wool produced in Kazakhstan is fine wool¹. This means that farms in the Dzhambul and the Almaty oblasts produce at a minimum 3,850 tons of fine wool (1,400 and 2,450 tons respectively).

Many of the largest Merino producing farms in the Almaty and Dzhambul regions, including the Almaty (15,000), Alrun (12,000), Merke (10,000), Pioneer (8,000), and Kurty (5,000) farm, were included in the sampling for at least one of the three years. Altogether, the sampled farms produce around 92,000 sheep and 276 tons of wool (3kg/sheep). This represents about 7.2% of fine wool produced in the two regions. The sampled farms in the Almaty region produce altogether around 67,000 sheep and around 201 tons of wool. This represents around 8.2% of fine wool produced in the Almaty oblast.

1.2 Wool Data by Breed.

During the Soviet period, the majority of Kazakh Merino wool was produced from four breeds, the Kazakh Finewool, the Southern Kazakh Merino, the Northern Kazakh Merino, and the Arkhar Merino. These breeds were developed on the basis of the local coarse wool sheep, the Kazakh Fat Tail, or KFT, and imported Merino breeds. In the

1970s these four breeds were bred with finewool Australian Merino sheep to improve wool quality.

During the post-Soviet transition, sheep breeding suffered a considerable setback due to the lack of state finances and economic crisis of the livestock sector. Sheep numbers fell from 35 million in 1990 to 9 million in 1998, and the percentage of Merino sheep fell from 65% to about 10-15% as a result of hybridization and proliferation of fat tail breeds. By 1999-2000, prices of sheep products began to recover. Meat prices increased largely as a result of the revival of the Kazakh economy and increased demand for meat on the local market. The world wool market experienced a partial recovery after a decade of declining prices. This led to the increase in wool prices in all wool producing countries including Kazakhstan. Since 1999, sheep numbers have risen to about 15 million in 2006. This trend was paralleled by an increasing interest in professional sheep breeding on the part of private farmers, and the few remaining former state breeding farms that survived the transition and continued to operate as new legal entities (partnerships, joint stock companies, cooperatives, and other). Although many small farmers and village households started to produce fat tail sheep for meat, some private farms and former Merino breeding farms focused on trying to preserve the remaining flocks of Merino breeds. The impetus for the continuation of Merino production also came from the Kazakh wool-processing sector. The ST Group, a wool buying and processing company, recently purchased 250 Merino sheep from Australia, and started working with large Merino farms to improve wool production and ensure the supply of quality raw material for its yarn-making plant³.

Figure 1. The main areas of wool sample collection in the Almaty oblast. A=Aksui region, D=Dzhambul region, R=Raimbek region.



Table 5 shows the distribution of the approximately 200,000 purebred sheep of the four Merino breeds that remained in Kazakhstan in 2005.

The remaining flocks of the four Merino breeds developed in Kazakhstan are primarily concentrated in the Almaty and Dzhambul oblasts. The most prevalent is the Kazakh Finewool sheep, which was developed in 1946. This breed is considered a meat

Table 5. Distribution of 200,000 purebred Merino sheep, 2005

Kazakh Finewool	47%
Southern Kazakh Merino	44%
Northern Kazakh Merino	7%
Kazakh Archar Merino	3%

and wool breed, and is predominant in the Almaty oblast. The two major breeding farms of the Kazakh Finewool breed are the Almaty and the Kurty farm. The Almaty farm was included in the sampling in 2004, 2005, and 2006, and the Kurty farm was included in 2005. According to governmental statistics, in 2006, there remained 92,312 purebred Kazakh Finewool sheep.

The Arkhar Merino breed was created by crossing the Australian type Merino sheep with the wild Arkhar sheep of the Tian Shian subspecies (there are five subspecies of the wild sheep in Kazakhstan) in the 1950s. Based on the literature, 60% of the first flocks of the Arkhar Merino breed had wool of 18-20.5 micron. However, their wool varied on different parts of the body, with fine wool on the

Merino rams at the Uzumbulak farm, Raimbek region. Photo by Liba Brent.



back, and coarse wool on the flank. The scientists were interested primarily in developing sheep with wool of 23-25 micron, because this type of wool was demanded by Russia's processing enterprises. They were also interested in the animal's adaptability and the weight of the fleece. The resulting Arkhar Merino breed that is bred in the Raimbek region has relatively uniform wool with FD of 22 - 24 micron. Currently, the scientists of the Kazakh Sheep Breeding Institute work to create experimental flocks by crossing the Arkhar Merino sheep of the Australian bloodline with the wild Arkhar sheep, with the objective to create a new genotype with superfine wool and increase longevity and weight. This work is being conducted on the Arkhar Merino breeding farm in the Uzumbulak village at the Raimbek region in southeastern Kazakhstan. The Uzumbulak farm (3,000 sheep) was included in the sampling in 2004, 2005, and 2006. Governmental statistics show that there are only 3,500 purebred Arkhar Merino sheep in the Raimbek region, but based on visits to farms in the region we assess the numbers to be at least 10,000. Many of the sheep are produced by private farms as opposed to the Uzumbulak breeding farm, and are not formally counted as purebred.

The third Merino breed is the Northern Kazakh Merino that was created in the 1970s,

using fine wool sheep imported from Russia. The Russian immigrants brought fine wool sheep to northern Kazakhstan in large number in the 1900s. Compared to the other two breeds, this breed has more fine wool blood and is larger. Unlike the Kazakh Finewool and the Arkhar Merino that graze all year and are fed supplements only in critical periods such as lambing, the Northern Kazakh Merino should be stalled for 6 months. This was possible in areas of northern Kazakhstan that produced large quantities of grains but had limited winter pastures. However, due to the need for supplemental feeding, the Northern Kazakh Merino was

produced in smaller numbers than the other two breeds. The Northern Kazakh Merino is produced by the Alrun and Musabek farms sampled in 2005, and the purebred animals total around 13,000 in Kazakhstan.

The Southern Kazakh Merino was created in 1965 in southern Kazakhstan. The sheep are much smaller than the Northern Kazakh Merino, and are adapted to the hot climate of southern Kazakhstan. The largest breeding farms of the Southern Kazakh Merino are the Merke and Pioneer farms located near

Taking a wool sample from a Kazakh Finewool sheep, Almaty oblast. Photo by Liba Brent.



Arkhar Merino ram, Uzumbulak farm. Photo by Liba Brent.



the city of Dzhambul. The farms were included in the sampling in 2005 and 2006. The population of purebred Southern Kazakh Merino is around 68,000.

The data in Table 6 shows that the three most prevalent Merino breeds produce wool of relatively similar quality, with FD between 22.29 and 23.69 micron and SD close to 5 micron.

Although the results suggest that the Southern Kazakh Merino sheep produce the finest wool, it is important to consider that the only Southern Kazakh Merino farms sampled were two former state breeding farms (Merke and Pioneer), and that no small or medium private farms were included. As shown in the next table (Table 7), the majority of former state breeding farms that currently operate as new legal entities (cooperatives, joint stock companies, partnerships, etc.) produce slightly finer wool than medium (1,000-500 sheep) and small (500-300 sheep) private farms⁴, regardless of the type of Merino breed. The samples of the Arkhar Merino, Northern Kazakh Merino and the Kazakh Finewool breeds were collected on both private farms and the former state farms, and the private farm data tend to increase the average FD.

1.3 Wool Data by Farm Type. During the Soviet period, all wool was produced on state farms with flocks of around 60,000 sheep. Fifteen years after privatization, sheep and wool production in

Kazakhstan has been highly decentralized. Most wool is currently produced by village households that survive through subsistence production of sheep and other livestock. The village household is currently the predominant agricultural production unit in Kazakhstan. Households produce around 22,360 tons of wool (about 78.5% of total wool production). 4,100 tons is produced by private farms (14.4%), and 7.1% by breeding farms, most of which are the descendants of former state farms.

Although the village households produce most wool in terms of volume, the majority of them produce medium or coarse wool from Merino–Fat Tail hybrids. The hybridization process began after the Merino sheep were privatized by village households that graze their sheep together, and do not practice breeding selection. The Merino sheep crossed with the native Fat Tail sheep, and the most predominant sheep in the villages are now Fat Tail

Table 6. Wool sample test results by breed.

Breed	# of samples	FD	SD	CF	Length
Southern Kazakh Merino (SKM)	233	22.29	4.74	89.4	91.85
Kazakh Finewool (KF)	2829	23.69	4.85	85.4	80.4
Arkhar Merino (AM)	735	23.63	5.2	85.17	79.56
Norther Kazakh Merino (NKM)	90	22.54	4.84	90.25	81.95

Arkhar Merino and Wild Arkhar sheep hybrids, Uzumbulak farm. Photo by Liba Brent.





Wool sorters at the Pioneer farm, Dzhambul region. Photo by Liba Brent.

sheep and Merino–Fat Tail crosses. This process contributed to the decline of Merino breeds from 65% to 10–15% in fifteen years of the market transition. The wool of white Merino–Fat Tail crosses (so called “budans”) sold for about 35cents/kg, or 1/3 of the price of Merino wool in recent years. The wool produced by black Fat Tail sheep has been difficult to sell for any price.

The finer, high-quality Merino wool is produced by the Merino breeding farms and by private farms, especially in the Almaty and Dzhambul oblasts. The large breeding farms sampled in the GL-CRSP study have altogether around 73,000 sheep that produce around 219 tons of wool. The private farms sampled total around 19,000 sheep and produce 57 tons. The income from wool for the farms is not negligible. At \$1.1 per kg, the farms earned around \$303,600 from wool in 2005.

The data in Table 7 shows that the eight former state breeding farms produce wool that is on average nearly one micron finer (22.86 micron) than wool produced by private farms (23.73 micron). This is because the former state farms continue to practice breeding selection with the assistance of scientists from the Mynbaevo Sheep Breeding Institute who worked at the farms during the Soviet period. The certified breeding farms also receive state subsidy for

each purebred animal sold, which provides an incentive to continue breeding Merino breeds. The large Merino farms work on contractual basis with wool buying companies such as the ST Group Company, which purchases around 3,000 tons of Merino wool for processing, or nearly 1/3 of fine wool produced in Kazakhstan. Unlike the medium and small private farms, the former state farms have wool collection points, shearing equipment and baling machines. They sort and bail the wool themselves, avoid the cost

of middlemen, and receive slightly higher prices for volume and quality.

Private farmers who acquired their Merino flocks from the state breeding farms during privatization often lack access to purebred animals, do not practice artificial insemination, and lack the needed breeding expertise. Most importantly, some private farmers do not see the incentives to continue breeding purebred Merino sheep due to the relatively low wool prices, and are switching to hybrids of Merino and the native Fat Tail breeds to increase meat production. Such hybrids are now produced on many small farms (500 – 300 sheep) that originally started with a Merino breed. According to interviews with farmers, the Fat Tail breeds are hardier, healthier and less costly to produce. The newborn Fat Tail lambs require less care than Merino lambs, and the Fat Tail ewes are larger than the Merino ewes and give more meat. The Fat Tail and Merino rams are of comparable weight. Many Kazakhs say they prefer the taste of meat of the Fat Tail breeds⁵.

These trends, together with Fat Tail sheep production by village households described earlier, have led to the decline in Merino sheep, and have affected wool production and quality. The increasing numbers of crossbred sheep in village flocks, and in the flocks of some private farmers, lead to an

Former state breeding farms (some privately owned, others partnerships, joint stock companies, cooperatives, etc.)						
Samples	Farm	FD	SD	CF	Length	Flock Size
163	Merke	23.04	5.24	87.20	96.30	15000
116	Alrun	23.14	5.04	87	86.3	12,000
70	Pioneer	21.54	4.24	91.60	87.40	10100
256	Almaty	24.54	5.09	79.10	71.90	15000
199	Eskeldy	23.64	4.84	84	88.5	5,500
184	Kurty	22.34	5.14	90.5	83.5	5,000
481	Kopa	21.84	4.44	92.1	73.6	3,000
163	Uzumbulak	23.34	4.84	87.3	80.2	3,000
20	Musabek	21.94	4.64	93.5	77.6	2,500
174	Karachok	23.24	4.84	87	70.3	2,000
1826	Total	22.86	4.84	87.93	81.56	73100
PRIVATE FARMS						
Samples	Farm	FD	SD	CF	Length	Flock Size
122	Myngasarov	22.84	4.34	89.6	89.5	3,387
50	Kumtekei	22.94	5.24	86.8	79.8	1,800
55	Aldzhanbaev	23.84	5.14	83.8	74.8	1,200
43	Kainar	23.84	4.84	85.9	73.7	1,200
143	Rakhmetov	23.04	5.44	86.9	82.9	1,000
103	Tyrsynbai	24.14	4.84	85.8	69.7	1,000
56	Moldesanov	24.64	5.14	80.4	76.2	900
102	Aidyn	24.64	4.94	82.6	78.3	665
47	Bazarbai	22.54	4.84	90.4	69.5	650
95	Tuleukulov	23.74	4.94	87.1	81.2	600
63	Dusembiev	25.14	5.14	79.5	85.7	600
20	Zhumagulov	22.04	4.24	94.1	77.6	600
169	Arai	23.74	4.74	85.5	95.8	520
100	Seilkchan	22.84	4.53	88.9	73.9	400
53	Nurgaliev	24.64	4.94	80.7	83.7	400
49	Abenov	24.84	5.04	80.3	89.9	400
99	Baimukhaev	23.64	5.09	86.05	83.9	400
40	Kusainov	22.94	4.74	89.6	81.2	400
24	Turturugov	23.44	4.54	88.7	64.6	350
80	Surtaev	23.54	4.74	86.2	80.9	350
61	Sarsebaev	25.44	5.44	77.3	87	350
95	Fazyl	23.94	4.69	84.85	84.6	300
104	Bekbolat	23.74	4.64	84	67.4	300
41	Dauletbakov	22.74	5.34	88.3	71.7	300
52	Bukienov	23.14	5.14	88.2	78.3	300
62	Bakaev	23.24	4.84	88.4	81.9	300
39	Zhylysai	24.84	5.44	79.6	89	300
74	Nogaibaev	24.34	5.34	82.7	79.8	300
2041	Total	23.73	4.94	85.44	79.73	19272

Table 7.
Comparison
of test results
of former state
breeding farms
and private
farms

Table 8. Comparison of test results per flock size, cooperative, and private farms.

15,000-10,001 head						
Samples	Farm	FD	SD	CF	Length	Flock Size
163	Merke	23.04	5.24	87.20	96.30	15000
70	Pioneer	21.54	4.24	91.60	87.40	10100
256	Almaty	24.54	5.09	79.10	71.90	15000
116	Alrun	23.14	5.04	87	86.3	12,000
605	Total/Ave	23.07	4.90	86.22	85.47	13025
5,500-1,001 head						
Samples	Farm	FD	SD	CF	Length	Flock Size
199	Eskeldy	23.64	4.84	84	88.5	5,500
184	Kurty	22.34	5.14	90.5	83.5	5,000
55	Aldzhanbaev	23.84	5.14	83.8	74.8	1,200
481	Kopa	21.84	4.44	92.1	73.6	3,000
174	Karachok	23.24	4.84	87	70.3	2,000
122	Myngasarov	22.84	4.34	89.6	89.5	3,387
163	Uzumbulak	23.34	4.84	87.3	80.2	3,000
50	Kumtekei	22.94	5.24	86.8	79.8	1,800
43	Kainar	23.84	4.84	85.9	73.7	1,200
20	Musabek	21.94	4.64	93.5	77.6	2,500
1491	Total/Ave	22.98	4.83	88.05	79.15	2,859
1,000-500 head						
Samples	Farm	FD	SD	CF	Length	Flock Size
143	Rakhmetov	23.04	5.44	86.9	82.9	1,000
47	Bazarbai	22.54	4.84	90.4	69.5	650
20	Zhumagulov	22.04	4.24	94.1	77.6	600
169	Arai	23.74	4.74	85.5	95.8	520
102	Aidyn	24.64	4.94	82.6	78.3	665
95	Tuleukulov	23.74	4.94	87.1	81.2	600
63	Dusembiev	25.14	5.14	79.5	85.7	600
56	Moldesanov	24.64	5.14	80.4	76.2	900
103	Tyrsynbai	24.14	4.84	85.8	69.7	1,000
798	Total/Ave	23.74	4.92	85.81	79.66	726

increasing percentage of kemp and dark wool fibers, a greater variability in fiber diameter, and a lower yield. In addition, the decentralization of sheep production has made it difficult to organize wool shearing, sorting and grading among farmers, which also contributes to a decrease in quality. Problems in wool quality are starting to cause difficulties for local wool processors such as the ST Group Company, which produces tops and yarn for export at the Kasiet factory, and is helping to finance the establishment of new knitting factories in Kyrgyzstan. These

newly emerging factories, located in Kyrgyzstan and financed by Kazakh investors, are expected to use locally produced yarn to make knitted clothing for export. The investment in the local textile industry that began in recent years is expected to generate new demand for Kazakh Merino wool. This may contribute to increasing prices for quality Merino wool.

1.3 Wool Data by Farm Size. Table 8 shows that the quality of Merino wool in terms of micron varies slightly with farm size.

Table 8 continued: Comparison of test results per flock size, cooperative, and private farms.

499-300 head						
Samples	Farm	FD	SD	CF	Length	Flock Size
100	Seilkchan	22.84	4.53	88.9	73.9	400
24	Turturugov	23.44	4.54	88.7	64.6	350
104	Bekbolat	23.74	4.64	84	67.4	300
41	Dauletbakov	22.74	5.34	88.3	71.7	300
52	Bukienov	23.14	5.14	88.2	78.3	300
62	Bakaev	23.24	4.84	88.4	81.9	300
39	Zhylysai	24.84	5.44	79.6	89	300
74	Nogaibaev	24.34	5.34	82.7	79.8	300
61	Sarsebaev	25.44	5.44	77.3	87	350
95	Fazyl	23.94	4.69	84.85	84.6	300
49	Abenov	24.84	5.04	80.3	89.9	400
99	Baimukhaev	23.64	5.09	86.05	83.9	400
40	Kusainov	22.94	4.74	89.6	81.2	400
80	Surtaev	23.54	4.74	86.2	80.9	350
53	Nurgaliev	24.64	4.94	80.7	83.7	400
973	Total/Ave	23.82	4.97	84.92	79.85	343

According to the statistics, the larger farms (15,000-10,000, 5,500-1,001) produce wool of around 23 micron, while the smaller farms produce wool that is nearly one micron coarser. The SD on larger farms is approximately 0.1 micron lower and the wool is slightly longer (85 versus 80mm). It is likely that these differences may become magnified in future years as a result of the breeding preferences of some smaller private farmers, who are more likely to focus on meat production.

According to the test results in Table 9, even after the former state breeding farms were omitted, the largest private Merino farms (5,500 – 1,000 animals) produce wool that is slightly finer (0.5 micron) than wool produced on farms with fewer sheep (900-300). However, the differences in SD and length are insignificant.

2. *2006 Core Test Results Compared with 2005 and 2004 Staple Tests.* The test results in Table 10 compare the quality of wool on live animals (Staple 2004 and 2005) with samples collected from wool bales using a coring tube in 2006 (Core 2006).

The core samples were collected from 1,650 bales on 6 farms that sort and bail wool themselves (Pioneer, Aspara, Zhylybulak, Merke, Uzumbulak

and Almaty) and at a wool collection point in the village of Uzynagach that sorts and bails wool collected on private farms in the Almaty region. The core samples were tested at the fiber lab of the ST Group Company using OFDA4000 in August and September 2006.

The test results show a slightly lower FD than the staple samples collected in 2005 (-0.95FD) and 2004 (-0.36FD). However, they show a higher variation than in 2005 (+0.32) and 2004 (+0.59). The lower FD can be explained by several factors: First, two Merino breeding farms, Aspara (600 sheep) and Zhylybulak (1,200 sheep) were included in the core sampling. Both of the farms produce Kazakh Finewool sheep and show low FD of 21.9 micron. Second, the 2005 staple samples were tested prior to the re-calibration of OFDA4000. Although the results have been adjusted by -1.5 micron FD and -1.26 SD, it is possible that the 2005 values are still slightly higher due to the calibration level at the time of testing. Third, the live sheep were sampled randomly whereas the core samples were collected primarily from bales with first grade wool - the longest staple and the finest FD⁶. (Wool on former state farms is sorted into three grades based on FD,

Table 9. Comparison of test results per flock size, private farms only

5,500-1,000 heads						
Samples	Farm	FD	SD	CF	Length	Flock Size
55	Aldzhanbaev	23.84	5.14	83.8	74.8	1,200
122	Myngasarov	22.84	4.34	89.6	89.5	3,387
50	Kumtekei	22.94	5.24	86.8	79.8	1,800
143	Rakhmetov	23.04	5.44	86.9	82.9	1,000
43	Kainar	23.84	4.84	85.9	73.7	1200
413	Total/Ave	23.3	5	86.6	80.14	1,717
900-500 heads						
Samples	Farm	FD	SD	CF	Length	Flock Size
169	Arai	23.74	4.74	85.5	95.8	520
102	Aidyn	24.64	4.94	82.6	78.3	665
95	Tuleukulov	23.74	4.94	87.1	81.2	600
63	Dusembiev	25.14	5.14	79.5	85.7	600
56	Moldesanov	24.64	5.14	80.4	76.2	900
103	Tyrsynbai	24.14	4.84	85.8	69.7	900
20	Zhumagulov	22.04	4.24	94.1	77.6	600
47	Bazarbai	22.54	4.84	90.4	69.5	650
655	Total/Ave	23.83	4.85	85.67	79.25	679.38
400-300 heads						
Samples	Farm	FD	SD	CF	Length	Flock Size
100	Seilkchan	22.84	4.53	88.9	73.9	400
24	Turturugov	23.44	4.54	88.7	64.6	350
104	Bekbolat	23.74	4.64	84	67.4	300
41	Dauletbakov	22.74	5.34	88.3	71.7	300
52	Bukienov	23.14	5.14	88.2	78.3	300
62	Bakaev	23.24	4.84	88.4	81.9	300
39	Zhylyesai	24.84	5.44	79.6	89	300
74	Nogaibaev	24.34	5.34	82.7	79.8	300
61	Sarsebaev	25.44	5.44	77.3	87	350
95	Fazyl	23.94	4.69	84.85	84.6	300
49	Abenov	24.84	5.04	80.3	89.9	400
99	Baimukhaev	23.64	5.09	86.05	83.9	400
40	Kusainov	22.94	4.74	89.6	81.2	400
80	Surtaev	23.54	4.74	86.2	80.9	350
53	Nurgaliev	24.64	4.94	80.7	83.7	400
973	Total/Ave	23.82	4.97	84.92	79.85	343

Table 10. Tests of core samples collected from wool bails in 2006 compared to staple test of 2005 and 2004.

Samples	Farm	FD Core 2006	FD Staple 2005	FD Staple 2004	SD Core 2006	SD Staple 2005	SD Staple 2004	CV Core 2006	CF Core 2006	Crimp Core 2006	Length Core 2006	Length Staple 2005	Length Staple 2004
181	Pioneer	20.7	21.54		4.8	4.24		23.2	96.3	84.3		87.4	
62	Aspara	21.9			4.9			22.2	93.8	76.4	85		
142	Zhylybulak	21.9			5.1			23.1	93.8	77.2	82.8		
313	Merke	22.3	23.04		5	5.24		22.6	92.6	71.2	87.8	96.3	
168	Uzumbulak	22.5	23.34	21.55	5.5	4.84	4.45	24.2	91.3	89.3		80.2	82.35
573	Almaty	23.2	24.54	23.5	5.4	5.09	4.7	23	89.1	81.8	75	71.9	78.5
121	Mixed Private Farms	22.7			5.5			24.2	90.9	84.3			
1560	Total	22.17	23.12	22.52	5.17	4.85	4.58	23.21	92.54	80.64	82.65	83.95	80.42

length and yield. Private farms often sell their wool in bulk, without sorting.)

The SD of the core samples is slightly higher than the SD for staple samples in 2005 and 2004. This can be explained by the greater variation of wool in the bale compared to wool fibers on the shoulder blade of the animal where the staple samples were collected. Grab samples of wool were collected on some of the farms in 2006 and they confirm an average length of over 80.5 mm for most farms.

The core samples collected at the Uzynagach wool collection point from bales that contained first grade wool produced by private farms in the Almaty region (i.e. mixed private farms) show a slightly higher FD (22.7) than all other farms except the Almaty breeding farm. The higher FD of core samples from the Almaty farm can be explained by the management's effort to cross the Kazakh Finewool sheep with a Meat Merino breed imported from Germany to increase weight while maintaining wool quality⁷. The SD for the mixed private farms is also slightly higher than for all other farms except Uzumbulak⁸. In spite of the small differences, the core sample test results show that bales of first grade wool produced at the Uzynagach wool collection point are comparable in terms of quality to wool produced by the Merino breeding farms.

The staff at the Uzynagach wool collection point has undergone training in wool sorting and grading in 2005 through the GL-CRSP project which most likely affected the quality of wool sorting in 2006.

3. Comparison of 2005 (OFDA4000) and 2004 (OFDA2000) Staple Tests. Table 11 compares staples from live animals collected on 27 farms in 2004 and 2005 and measured using OFDA2000 and OFDA4000.

The OFDA2000 shows a consistently lower FD and SD measurements for nearly all farms in all three regions compared to the OFDA4000 results, even after the adjustments of the OFDA4000 results after re-calibration. The average FD for OFDA4000 is 23.77 compared to 22.54 for OFDA2000. The

Merke farm shearing crew preparing to shear. Photo by Liba Brent.

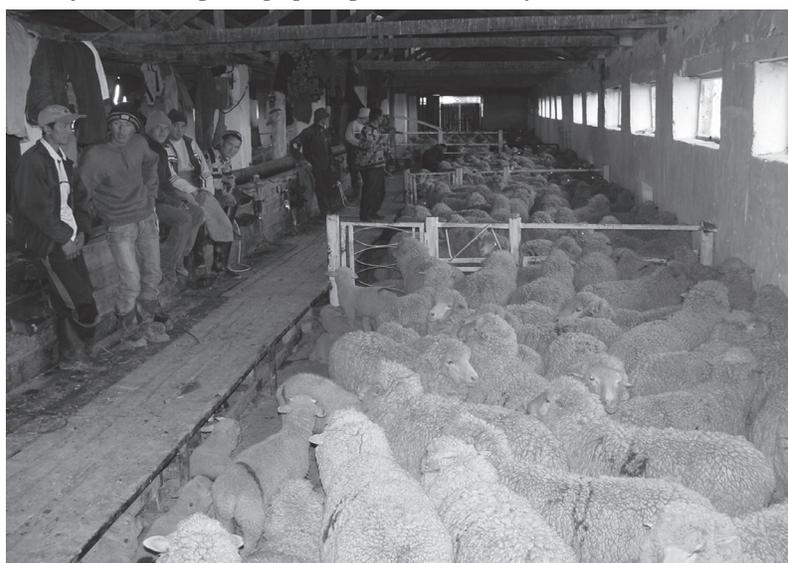


Table 11. Comparison of wool staple tests conducted in 2004 using OFDA2000 and in 2005 using OFDA 4000.

Name of Farmer	Number of Sheep	FD 2005 OFDA 4000	FD 2004 OFDA 2000	FD 2005 - FD 2004	SD 2005 OFDA 4000	SD 2004 OFDA 2000	SD 2005 - SD 2004	Length 2005 Manual	Length 2004 OFDA 2000	Length 2005 - Length 2004
Abenov	650	24.84	21.9	2.94	5.04	4.6	0.44	89.9	76.3	13.6
Fazyl	500	23.94	22.6	1.34	4.69	4.5	0.19	84.6	70.2	14.4
Tulekulov	1,200	23.74	22.8	0.94	4.94	4.3	0.64	81.2	75.4	5.8
Kusainov	700	22.94	22.8	0.14	4.74	4.7	0.04	81.2		81.2
Sarsebaev	700	25.44	22.9	2.54	5.44	4.8	0.64	87	77.4	9.6
Baimukhaev	650	23.64	23.1	0.54	5.09	4.7	0.39	83.9	74.4	9.5
Nurgaliev	600	24.64	23.1	1.54	4.94	4.7	0.24	83.7	74.6	9.1
Surtaev	500	23.54	24	-0.46	4.74	5	-0.26	80.9	78.9	2
Dusembiev	1,000	25.14	24.7	0.44	5.14	4.7	0.44	85.7		85.7
Averages		24.21	23.10	1.11	4.97	4.67	0.31	84.23	75.31	8.92
Name of Farmer	Number of Sheep	FD 2005 OFDA 4000	FD 2004 OFDA 2000	FD 2005 - FD 2004	SD 2005 OFDA 4000	SD 2004 OFDA 2000	SD 2005 - SD 2004	Length 2005 Manual	Length 2004 OFDA 2000	Length 2005 - Length 2004
Too Kopa	1,000	21.84	21.1	0.74	4.44	3.83	0.61	73.6	73.16	0.44
Eskelde	5,500	23.64	21.8	1.84	4.84	4.65	0.19	88.5	66.93	21.57
Karachok	1,000	23.24	21.85	1.39	4.84	4.6	0.24	70.3	71.2	-0.9
Aidyn Farm	665	24.64	21.85	2.79	4.94	4.25	0.69	78.3	66.4	11.9
Myngasarov	3,387	22.84	21.97	0.87	4.34	4.43	-0.09	89.5	64.47	25.03
Chatimoldaev	550	22.84	22.2	0.64	4.53	4.5	0.03	73.9	71.2	2.7
Sarybulak	1,150	25.64	22.5	3.14	5.34	4.3	1.04	98.2	85.43	12.77
Arai	625	23.74	23.5	0.24	4.74	4.43	0.31	95.8	83.13	12.67
Almaty	15,000	24.54	23.5	1.04	5.09	4.7	0.39	71.9	78.5	-6.6
Tyrsynbai	1,000	24.14	24.3	-0.16	4.84	5.4	-0.56	69.7	80.2	-10.5
Averages		23.71	22.46	1.25	4.79	4.51	0.29	80.97	74.06	6.91
Name of Farmer	Number of Sheep	FD 2005 OFDA 4000	FD 2004 OFDA 2000	FD 2005 - FD 2004	SD 2005 OFDA 4000	SD 2004 OFDA 2000	SD 2005 - SD 2004	Length 2005 Manual	Length 2004 OFDA 2000	Length 2005 - Length 2004
Bakaev	300	23.24	20.9	2.34	4.84	4.5	0.34	81.9	76.8	5.1
Dauletbakhov	300	22.74	21.5	1.24	5.34	4.7	0.64	71.7	84.4	-12.7
Uzumbulak	3,000	23.34	21.55	1.79	4.84	4.45	0.39	80.2	82.35	-2.15
Moldosanov	900	24.84	21.6	3.24	5.29	4.8	0.49	77.2	78.9	-1.7
Rakhmetov	1000	23.04	21.82	1.22	5.44	4.77	0.67	82.9	74.05	8.85
Bukienov	200	23.14	22.9	0.24	5.14	4.9	0.24	78.3	75.6	2.7
Alzhanbaev	1,100	23.84	22.8	1.04	5.14	4.7	0.44	74.8	78.4	-3.6
Kymtekei	1500	22.94	23.4	-0.46	5.24	4.5	0.74	79.8	79.3	0.5
Averages		23.39	22.06	1.33	5.16	4.67	0.49	78.35	78.72	-0.38

average SD is 4.97 for OFDA4000 and 4.62 for OFDA2000. These differences can be explained by: 1) the difference between measuring unwashed samples (OFDA2000) and washed, minicore samples (OFDA4000); 2) a coefficient applied during the OFDA2000 testing that was set to measure Australian wool and may have to be adjusted to measure Kazakh wool; 3) air climatization at the ST Group wool lab was not yet installed and the humidity might have affected the FD; 4) the 2005 values produced by the OFDA4000 remain slightly higher even after being adjusted; and 5) the 2005 wool might have been coarser due to weather conditions that year.

The comparison shows that the largest FD variations (2+ micron) occurred on two private farms in each of the three regions of the Almaty oblast. This would be consistent with the shifting breeding preferences of some private farmers who either chose to breed Merino hybrids to increase meat production, or simply lack the interest in fine wool production and in breeding purebred animals. FD also increased on some of the former breeding farms in the Aksui region (Almaty, Eskeldy, and Karachok). This trend may be explained by the breeding work of Dr. Tulubek Kasenov who works on all these farms and is focused on producing a new hybrid sheep through crossing the German Meat Merino and the Kazakh Finewool. The Meat Merino rams have semi-fine wool of 26 micron and could be increasing FD at the farms. However, the 2006 core test at the Almaty farm (Table 10) showed that the farm produces wool of 23.2 micron, which is closer to the 2004 results of 23.5 micron obtained using the OFDA2000. New samples from these farms will need to be measured and improvements in fiber testing will be required in both laboratories⁹ to answer questions

that arose in the course of sample testing during the GL-CRSP project. Regardless of these questions, the data provide important information about the quality of wool produced on Kazakh Merino. The wool testing process demonstrates the growing capacity of the local fiber laboratories to obtain the newest Australian technology, and to use it to assess the quality of local fibers.

4. *Data on Australian wool.* Table 12 shows the test results of 219 samples of Australian sheep that were imported to Kazakhstan in 2005.

The samples were collected and tested using OFDA4000 at the ST Group Company fiber lab in August 2006. The test shows that the wool of the Australian Merino sheep has an average FD of 20.24 micron, about 3 micron finer than the 23.28 average for the Kazakh Merino breeds. Even more importantly from the processor's viewpoint, while Kazakh Merino wool has SD of around 5 micron, the average SD of the Australian Merino sheep is only 3.56 micron. This means that the Australian wool is more consistent. In addition, the Australian wool is on average 1.5-2 cm longer than the wool of Kazakh Merino sheep. The OFDA2000 staple graphs showed that a large percentage of Kazakh wool has a break point at approximately 2/3 of the staple length, resulting from malnutrition during the winter months and the lambing season. This means

Table 12. Australian Sheep, 2006 data.

Sample	Breed	Sex	FD	SD	CV	CF	Curv	Length
12	Poll Merino	M	19.4	3.5	18.2	99.1	63.1	99
38	Merino	M	19	3.3	17.4	99.4	62.7	98.5
44	Poll Merino	M	21.5	3.4	16.3	92.1	54.1	108.8
8	Merino	M	19.9	3.2	15.9	99.6	64.5	85.9
7	Dohne	M	20.8	3.6	17.1	98.8	72	96.8
3	Polwarts	M	22.1	3.8	17.1	98.4	59.8	98.7
7	Polwarts	M	22.1	3.8	17.2	97.8	75.4	105.9
8	Meat Merino	M	19.1	3	16	99.8	63.2	121.9
Sample	Breed	Sex	FD	SD	CV	CF	Curv	Length
21	Dohne	F	18.8	3.3	17.7	99.7	73.2	77.9
15	Polwarts	F	21.2	4.3	20.6	96.9	68.7	95.6
27	Polwarts	F	20.7	4.2	20.4	97.3	73.3	90.5
29	Meat Merino	F	18.3	3.3	18	99.6	62.1	127.9
Avg			20.24	3.56	17.66	98.21	66.01	100.62

that the Kazakh wool would most likely perform poorly when tested for strength. This defect has also been observed by the project team in the process of sample collection. Although this is not shown by the data, the ST Group laboratory director, Assel Imasheva, noted that the Australian wool has a higher yield and whiter lanolin.

These differences in quality partially explain the difference in market prices paid for the Kazakh and the Australian Merino wool – in 2003 1 kg of Australian wool of the same FD sold for about \$1 more compared to Kazakh wool. Gate prices for in 2003 gate prices for wool of the same FD differed considerably for Kazakh, American and Australian farmers. The differences continued in 2004 and 2005. In 2005, 1kg of clean Kazakh Merino wool of 18-24 micron sold for \$3.1 on the local market, while Australian Merino wool of 18-24 micron sold for \$10.1/kg.

Although the difference in quality between Australian and Kazakh wool is undisputable, not all of the price difference can be explained by the differences in quality. A portion of the price difference is the result of the relative marketing capacities of the Kazakh and Australian producers and traders – i.e. their ability to deliver properly sorted, tested, and baled wool to the market with quality guarantees. It has long been the case that the Australian producers and traders, who operate in a sophisticated, well-organized market, delivered wool of certified quality to buyers and processors. Consequently, Australian wool established its reputation on the market, and wool mills in different parts of the world became familiar with it. The Kazakh producers and traders have been unable to effectively market their wool as a result of a lack of marketing experience, low quality standards, and the absence of marketing infrastructure such as testing labs, wool pools and trading systems. Although the marketing capacities and quality standards of Kazakh producers and buyers have improved, partially due to the collaborative activities of the GL-CRSP project, additional improvements in wool production and marketing process will be necessary to improve marketability, value, and competitiveness of Kazakh wool and wool products. The Kazakh Merino farmers who took part in the wool sampling,

and the buyers and processors who worked with the GL-CRSP project on testing the samples, realize that their collaboration is essential for improving wool quality and price, and for the production of competitive wool products in Kazakhstan and Kyrgyzstan.

5. Conclusion. The wool data collected and tested during the three years of the GL-CRSP project set the baseline for assessing wool quality in Kazakhstan during the post-Soviet period, and will continue to provide an important source of information for Kazakh wool producers and local and international wool buyers and processors. The data will make it easier for farmers, wool buyers, and processors to accurately price Kazakh Merino wool and evaluate its spinning properties. The Kazakh wool buyers such as the ST Group Company already started to refer to the data when purchasing wool on different farms, and some of the farm directors actively used the data to bargain for fair prices. The data also

Dr. Kasenov examining a Meat Merino ram used at the Eskeldy farm. Photo by Liba Brent.



provides important information for Kazakh sheep scientists who work on improving wool quality through breeding and selection. The GL-CRSP project highlighted the interdependence between all participants in wool production, marketing, and processing, and facilitated collaboration among them. The close partnership between the local scientists, farmers, wool buyers, and processors and the GL-CRSP researchers that developed in the course of the project will serve as a good foundation for further collaboration.

Evaluation of variability within flocks and between flocks in average fiber diameter of flocks of sheep in Kyrgyzstan.

Progress. A research project to evaluate fiber diameter variability between flocks utilizing the OFDA2000 fiber diameter analyzer was initiated. This information would provide an indication of the degree of fiber diameter variability seen within flocks and between flocks in 4 flocks of fine wool sheep that have over 200 head, and in 4 flocks of sheep with 50 or fewer head. This would also assess wool quality within each of the farmer's flocks. Fiber diameter is the main physical characteristic that determines relative price; however variability in the diameter can have an adverse effect upon processing characteristics. There is very little known in Kyrgyzstan about the degree of variability in diameter seen in fine wool sheep. This knowledge would provide a basis for guidance for farmers in their breeding programs and also give them a much better concept of how much variability in diameter there really is within their flocks.

Nine farmers participated in this study, however, we failed to obtain samples from farmers with fewer than 50 head, as these farmers were not interested in their wool since they could not market it effectively at the time. The average fiber diameter ranged from a low of 21.5 microns to a high of 27.6, with an average of 22.7 microns. (Table 14) The variability (CV) indicated that generally the fleeces are slightly more variable for their respective diameters than is

Table 14. Comparison of wool staple tests from farmers in Kyrgyzstan conducted in 2006 using OFDA2000

Name of Farmer	Number of Sheep	FD 2006	SD	CV %
J. Jumakov	545	23.5	4.25	18.1
K. Tynaliev	345	21.5	3.98	18.5
B. Alymkulov	1,800	21.9	4.61	21.1
A. Saralev	365	21.5	4.21	19.6
B. Mamyrov	460	23.2	4.86	20.9
S. Kashkarbaev	850	27.6	6.12	22.2
S. Mykuev	490	20.5	4.1	20.0
M. Bokonbaev	380	23.2	4.66	20.1
K. Babtaev	250	24.3	5.14	21.2
I. Kadyrov	85	22.5	4.65	20.7
Averages		22.97	4.66	20.23

normally seen. This is the result of utilizing rams that are average in respect to variability of the diameter of their fleeces. The one area not reported was the staple strength of the staple, as this was a subjective measurement. Generally, all farms produced wools that were on the tender side, which means the staple pulls apart easily. This is symptomatic of variability in feed availability over a year's period. This is a management problem that wasn't an activity outlined in the Wool Project, however, staple strength does play an important role in processing of the fibers, and should be addressed in future work.

Provide market information on global prices and demand for cashmere to producers and traders in cashmere goat regions of Kazakhstan and Kyrgyzstan

For a detailed description of this subactivity, please see Activity 3 of the Cashmere component of the WOOL project report, immediately following this report.

Assess impacts of farmer training workshops in Kyzl Orda province of Kazakhstan

For a detailed description of this subactivity, please see Activity 1, Objective 2 of the Cashmere component of the WOOL project report, immediately following this report.

Women's roles in decision making in livestock enterprises.

Progress. The role women play in decision making relative to the running of the household

and also the livestock operation will be outlined, and although this doesn't have a strong bearing on the objectives of the project, we have a very good opportunity to provide information that is scarce relative to women's roles in agriculture in the former Soviet Union. Households where we have previously collected survey data will be utilized.

During her work at the sheep farms in Kazakhstan, Liba Brent interviewed women in the villages and on the farms about their work and about the changes in their livelihoods after the market transition. Based on these discussions, the lives of men and women in Kazakh villages were profoundly affected by the transition, especially by the dissolution of state farms. During the Soviet period, virtually all men and women in the villages worked outside their homes as shopkeepers, teachers, nurses, administrators, accountants, and farm workers, and earned their own income. In the course of the transition the farms dissolved and jobs disappeared. The village households became the main agricultural production units in the countryside, and the majority of the households focused on subsistence production of livestock – 50-60 sheep, 4-5 cows and 3-4 horses. Men tried to search for work outside the home to supplement the small family income from selling livestock, and in some cases livestock products such as milk. Most women stayed home and focused on small-scale food production and processing. Instead of buying food in the stores as they did during the Soviet period, they started to make bread, butter, and cream, milk cows and horses, and plant potatoes and other vegetables with the effort to save on food expenses. They also had to perform all household chores and childcare activities because the state-funded kindergartens in the villages closed down. In addition, many women had to start caring for the sick and the elderly who used to rely on free hospital care during the Soviet period. During the transition, the majority of rural hospitals also closed down, and those that remain open are no longer affordable for most villagers. In addition, the public transport women rely on became more expensive and much less frequent in the rural areas. This contributed to the decreased mobility of rural women.

Unlike the city women, many of whom found work selling things at the market, rural women have

had many fewer job opportunities and rely primarily on their husbands for income. In other words, rural women became more dependent on their husbands for livelihood after the decline of the Soviet Union, and became tied to unpaid work at their homestead. Given that there are very few jobs in the countryside, most husbands have difficulties supporting their family, and women have very few resources to rely on as they try to feed and clothe their children and support the elderly members of the family. Many women are very interested in learning new ways of processing and marketing animal products such as wool or mohair (including making handspun yarn or blankets) to generate income, gain more economic independence, and improve their family's welfare.

Activity 2: Training on fiber quality handling at the farm

Problem Statement and Approach. In order to supply high quality fiber to markets, Kazakhstan and Kyrgyzstan need to assist producers and buyers in sorting and classing wool and cashmere to improve quality and prices. Many wool producers and buyers lack training in preparing and sorting wool, and in assessing wool quality. This lack of capacity results in a poor preparation of wool at the farm level, poor sorting at the collection points, unfair pricing of wools collected by middlemen buyers, and a low quality of wool in bales marketed to processors. The team focused on training wool sorters who then worked on farms during shearing, and assisted farmers with proper wool sorting. Cashmere workshops focused on how to increase profit from selling fine fibers by getting farmers to sort their cashmere into grades and form village marketing cooperatives to sell in bulk at higher prices to large-scale buyers from Almaty.

Progress.

1. *Seminar in wool sorting and marketing at the Semipalatinsk scouring plant.* The GL-CRSP project organized a training workshop for thirty-four farmers, wool sorters, traders, and buyers at a wool-scouring plant in the city of Semipalatinsk from April 17 – 22, 2006. The project collaborators from the Quality Center of the KazRuno wool processing company worked as trainers. The workshop

Training in wool sorting at a wool collection point. Photo by Liba Brent.



program included a presentation on wool testing, classing, and sorting standards used in Kazakhstan. The participants learned about a variety of wool measurements such as FD, length, and yield, and how to use them to sort dirty wool. They also learned about the formation of wool prices and the effects of specific quality standards on price. All participants took part in practical training in wool sorting and grading.

The director of the ST Group fiber laboratory demonstrated the process of core sampling, and showed photographs and video of testing wool samples using OFDA4000. The farmers, wool buyers, and processors discussed how to work together to collect and test wool samples, and what are the most effective methods of preparing, sorting, and grading wool. They learned about sheep production in other countries, and about the most recent changes of the world wool market, including increased competition and focus on quality. Specialists from the wool processing enterprise Kasiet explained to farmers and wool buyers about some of the defects in finished wool products that originate in the process of wool production, preparation, and marketing. The processors presented samples of finished products made from wool produced by some of the sheep farmers who participated in the seminar, and discussed the strength and weaknesses of the specific wools.

The participants also learned about a project led

by the ST Group Company that focuses on the development of fine wool production in Kazakhstan. The ST Group Company purchased 250 Australian sheep and Russian Merino sheep from the city of Stavropol to initiate a breeding program, which seeks to improve wool quality in Kazakhstan. Some farmers who will be working with the imported sheep participated in the seminar.

The seminar offered practical training and a forum for the discussion of wool production and processing in Kazakhstan

in the post-Soviet, market-led environment. It provided an opportunity for the producers, buyers, and processors to discuss specific problems in the wool production and marketing process, understand their interdependence, and to promote collaborative solutions that would benefit all participants in the complex process of sheep breeding, wool marketing, and the production of competitive wool products.

2. Training Tour of a Commercial Wool Processing Facility. One of the most effective training tools is the actual observance of how wool preparation can either add value to wool or make it less valuable. Touring a wool processing facility that takes greasy wool through to yarns and fabric allows participants to actually observe the problems that a commercial facility faces when processing wools that are contaminated or are a mixture of various diameters and staple lengths. This tour was not conducted due to financial and time restraints of Kazak and Kyrgyz farmers.

3. Shearing Training School. A problem all wool-producing countries are facing is the lack of people that shear sheep as a profession, as well as the age of sheep shearers currently working. There are few young people learning how to shear. A recent Australian report indicated that Australia currently has fewer than 7,000 shearers, compared to over 30,000 in the 1980's. Kyrgyzstan is no exception, that is the one problem both farmers and shearers expressed during the wool workshops conducted

last year. A shearing school will be held in the Bishkek region, to provide a means of training young people how to shear. Shearing methods, equipment, maintenance of equipment, and shearer responsibilities will be outlined.

This shearing school was held on May 24th, 2006 in Kichikemin village. Ten beginning shearers from 5 different regions of the country participated in the training session with 3 trainers, who provided a lot of individual attention to each shearer. The objective of the shearing school was not only on learning proper shearing techniques but also on value adding. In addition to learning the techniques of shearing, the participants were provided with information on animal management to prevent foreign contamination, schooled in management decisions that occur during shearing that keep the wool clean, instructed in sorting techniques to remove material that detracts from value, and given advice on how to establish lines of wool of similar diameter and fiber length. They were introduced to the importance of fiber diameter and variability to processing, and were taught why preparation and shearing of wool was an important step that influences the value of the raw product at the farm level and further down the pipeline.

In addition to the shearers, 10 students and their instructor from the Kyrgyz Ag Academy attended the session. This was held in conjunction with an agricultural production class the students were currently enrolled in. A reporter for a local newspaper attended, as well as the head of the local village administration, the head of the Kyrgyz Government Ag Development Department, and the local veterinarian. At the end of the shearing school, the participants were presented with the shearing equipment they used during the session, providing the working tools necessary for these shearers to actively start shearing in their respective regions.

4. Cashmere combing, grading and sorting school. The purpose of the training session was therefore fourfold: 1) to inform farmers and cashmere producers about the definition of cashmere, and how to improve the production of the fiber from their goats; 2) to instruct outreach workers, scientists, and laboratory technicians about cashmere quality and fiber testing regimes; 3) to provide farmers, traders,

and KSBA personnel with the training to effectively increase down yield and length of fiber by combing goats, rather than shearing; and 4) to provide the hands on experience of the most important physical characteristics of what is and is not high quality down, and how to differentiate between the qualities of cashmere.

As a biological definition, all goats, except the Angora goat, which grows mohair, have a coat with a double structure (i.e. cashmere), the seasonally grown and shed fine undercoat and coarse outer guard hair. However, when cashmere is traded as a textile fiber, it has a commercial definition regarding the acceptable limits of mean fiber diameter and mean cashmere length. Generally speaking, the cashmere should be under 18.5µm and 40-60 mm long, but there are different grades of cashmere within this overall definition that are decided by buyer preference and end-use of the fiber. Small differences in mean fiber diameter and fiber length can have a large impact on the value of cashmere and its suitability for end-use. Therefore, it is important for primary producers of cashmere fiber to understand the commercial definition of cashmere, how changes in the quality of their cashmere can affect the value of their cashmere, and how the value of cashmere affects their income.

In a laboratory situation where the cashmere is being tested for diameter and length the technicians and scientists need to have an appreciation of cashmere quality and value, as they will be required to advise the primary producers on the suitability of their cashmere for sale. The technicians and scientists should also have an understanding of testing regimes and their suitability for gathering the information required for animal breeders or textile processors.

The training session was well attended with 40 participants from 13 villages who owned a total of 805 goats.

5. Promote group cooperative marketing.

For a detailed description of this subactivity, please see Activity 2, Objective 1 of the Cashmere Component of the WOOL project report, immediately following this report.

6. Representative regional sampling of cashmere quality in areas previously identified as likely to have

good quality indigenous cashmere goats in both host countries.

For a detailed description of this subactivity, please see Activity 2, Objective 2 of the Cashmere Component of the WOOL project report, immediately following this report.

Activity 3: Finding New Market Options: From Producer to Processor.

Problem Statement and Approach: The objective is to find new marketing options for wool producers in Central Asia. Our research has identified the following opportunities for expanding market for higher quality wools produced in Kazakhstan and Kyrgyzstan:

Progress.

1. *Supplying producers of high-end fiber handicrafts such as luxury felt accessories produced in Kyrgyzstan with high-quality wools.* The producers of felt handicrafts in Kyrgyzstan need higher quality Merino wool to produce fine felt clothing and accessories for export. Many of these workshops are located in the capital city and do not have direct contact with Merino producers in the countryside. Liba Brent provided information on Merino farms to felt artisans in Bishkek, and facilitated a visit by the representatives of two artisan groups to the Orgochor Merino breeding farm in the Issyk Kul region. The artisans showed the farmers felt scarves and purses made from Merino wool, and agreed to purchase 300kg of selected, sorted Merino wool from the farm for 70 tenge/kg (\$1.75). (The price for unsorted Merino wool at the time was \$40 tenge/kg (\$1). The director of the Orgochor farm agreed to deliver the wool to the artisans after shearing. Upon the successful delivery of the wool, the artisans and the director agreed to continue collaborating on further deliveries.

2. *Working with a wool processing plant in Kyrgyzstan to facilitate direct deliveries of wool to the plant.* Liba Brent planned to facilitate direct deliveries of wool produced by Merino farms in Kyrgyzstan to the Kasiet wool processing plant in 2006. Kasiet is a joint Kazakh-Kyrgyz enterprise located in Tokmok, Kyrgyzstan. The plant currently

processes 3,000 tons of wool per year to make yarn and tops for export, but does not work directly with Kyrgyz Merino producers. Instead, it purchases a small amount of Kyrgyz wool through middlemen buyers. Although the possibility of direct deliveries was discussed with the director of the Kasiet plant in 2005, in 2006 the top management of the Kasiet plant changed and the new director decided to purchase wool from Kazakhstan only. This made it impossible to make progress on this activity.

3. *Advertising Kazakh and Kyrgyz wool on the international market, and inviting foreign buyers to work on the market.* Large, international wool-buying companies are uninformed about the qualities and quantities of wool available in Kazakhstan and Kyrgyzstan, and do not have linkages to the market. The project plans to offer the data on wool collected at the pilot region to international wool buyers and to invite representatives of the wool buying companies to visit some of the farms, and work on the market. Participation in the biannual IWTO (International Wool Textile Organization) meeting, which brings together growers, early stage processors, late stage wool processors, and product development groups, would provide valuable contacts with both the international wool buying community and early stage processors. Collaborating with wool buying companies in the United States to provide the type of data previously described would provide another avenue for increased interest in wools produced in Central Asia. Kazakhstan and Kyrgyzstan recently became joint members of IWTO, and have seen the potential economic benefits of participating in these meetings.

Progress. Mr. Akylbek Rakaev attended the fall meeting of IWTO, held in Biella Italy. This was an opportunity for networking with many of the buyers of greasy wool from the main processing countries. Mr. Rakaev established many contacts from which to start informing the world market about Kyrgyz wool. There were numerous seminars and meetings that were attended. These ranged from technical sessions, which are scientific meetings that dealt with IWTO Standard Test Methods, supply chain sessions, demand chain sessions, supply meets demands sessions, and a market intelligence session. There was a tremendous opportunity to meet with

prospective purchasers of Kyrgyz grease wools. Mr. Rakaev established numerous contacts with German, Indian, and Chinese buyers and processors. It was also an excellent opportunity to observe the international wool industry and the problems many countries are facing, and how they are responding to the problems. He also established contacts with the major wool testing firms. Mr. Tim Parkes, the new director of the New Zealand Wool Testing Bureau located in England, invited him to England to observe the English wool auction system, see first hand how the English wool market works and the types of fibers they offer.

Mr. Rakaev did have the opportunity to interact with Mr. Terry Martin, owner of Anodyne Wool, a US based wool-buying company who specializes in exporting of US wools. Mr. Martin was very interested in Kyrgyz wool and the potential opportunities. However, due to timing of the shearing and marketing seasons between the US and Kyrgyzstan, it was not possible to have Mr. Martin travel to Kyrgyzstan to view the Kyrgyz clip.

4. Develop small custom wool processing systems for small groups of farmers. Increased demand for smaller quantities of high quality wools are increasing with the increased popularity of the high-end handicraft market. As stated above, these producers of high-end handicrafts need smaller amounts of high-quality processed wool. The large processing companies can't afford to deal with such small quantities, however, small processing facilities in villages that have access to high quality wools, could process these smaller quantities and provide the types of raw materials required by these artisan groups. The owners of the wool could process it directly and market it to these groups, eliminating all channels in-between, thus increasing their returns from the wools they grow.

Progress. KSBA staff put together a small hand operated wool scouring system, however, the project couldn't be finished within the project time frame. A small carding machine was purchased and small lots of hand scoured wool have been carded and provided to handicrafters.

5. Inform international and domestic buyers of

the quality and quantity of cashmere available. For a detailed description of this subactivity, please see Activity 3, Objective 1 of the Cashmere Component of the WOOL project report, immediately following this report.

6. Regional meeting of representatives from cashmere-producing countries. For a detailed description of this subactivity, please see Activity 3, Objective 2 of the Cashmere Component of the WOOL project report, immediately following this report.

Activity 4: Advanced Training and Advice on Wool and Cashmere Fibers.

Problem Statement and Approach: Provide field and laboratory training to fiber technicians from the KSBA laboratory (Bishkek), the German GTZ-funded cashmere project (Osh), and the ST textile company (Almaty). Fiber technicians in these three organizations will be expected in the future to be able to assess raw cashmere from farmers' goats in the field, prior to the decision of whether their organizations should purchase cashmere from a particular area. Field assessments can only be made by subjective methods, in the absence of laboratory equipment. Subjective assessments of cashmere are based on fineness, crimp, shine, color, and style; this is a task requiring specialized skills that differ from wool assessment in which the fiber technicians already have a background. Therefore, in-field training will be provided to fiber technicians, using demonstration goats in villages in some of the target areas of Kazakhstan and Kyrgyzstan. In addition, lab-based training will be provided to the same fiber technicians, using the OFDA 2000 and OFDA 4000 equipment respectively in KSBA Bishkek and ST Company in Almaty. Training demonstrations will use the 300 cashmere samples to be collected under Activity 2. Laboratory tests will cover the indicators required by international cashmere processors.

Progress: Two workshops were held, one in Bishkek and the other in Almaty. The Bishkek workshop was held at the office of KSBA. Six attendees were from the Kyrgyz Agricultural University, 5 were KSBA staff/managers, and 1

journalist. The workshop covered fine fibers, what they look like (electron microscope images), and the relationship between fiber type and processing performance, high quality fiber production from goats, cashmere fiber qualities, and raw cashmere prices from Central Asia for the 2004/2005 season. Cashmere samples collected from goats during the cashmere production workshop held earlier were discussed and measured using the OFDA2000. Ms. Redden also gave a lecture entitled “High quality fiber production from goats and cashmere fiber quality” to students and faculty of the Kyrgyz Agricultural University in Bishkek.

The other workshop was held at the Almaty University of Technology, situated adjacent to the ST Group offices (where the OFDA4000 is located). In attendance at this workshop were 4 members of the ST Group, 7 members of the Technology of Textile Processing Industry Department Technology University of Almaty, and 4 personnel from Mynbaevo Sheep Breeding Institute. The training program was similar to the one conducted in Bishkek with some additional components that were requested from participants. The additional topics included: combing versus shearing of cashmere, yield estimation on the whole fleece, yield estimates from samples, and sampling for fiber diameter measurements. Four of the samples measured by the OFDA2000 in Bishkek were also measured on the OFDA4000. Table 15 provides the comparison between the two instruments. These results show quite good correlation between the two instruments when measuring cashmere samples.

Table 15. Comparison of fiber tests measured on the OFDA2000 in Bishkek, Kyrgyzstan and the OFDA4000 in Almaty, Kazakhstan

sample #	OFDA2000	OFDA4000	difference
	Fiber Diameter		
	(um)	(um)	
1	20.8	20.6	0.2
2	19.5	20.2	-0.7
3	17.5	18.3	-0.8
4	17.4	17.8	-0.4

GENDER

Kazak and Kyrgyz women, in common with women in other parts of Central Asia, have traditionally processed livestock fiber products from sheep, goats, and camels into homemade articles such as carpets and clothing. Sometimes these articles are sold by women and provide a much-needed source of cash income. In handling wools and fibers, women comb, clean, sort, card, spin, weave, and knit, as well as make felt and knotted carpets. When male household heads were interviewed about production and sales of wool and other fibers, they frequently referred to their wives for accurate information, which rarely occurs in the case of other household livestock management questions. Central Asian women are knowledgeable about and interested in wool and animal fibers, and should therefore be a focus of development efforts to improve marketability of these commodities.

While we have not focused our research to date on the differences the research might have on women and men, our research team includes an anthropologist with extensive experience working with sex and age disaggregated data on pastoral household systems.

The flocks of sheep and goats in the households we have worked with are generally in the hands of men. However, women do a lot of the milking and food processing work. It might be hypothesized that if cashmere combing becomes more prevalent, it might have a negative affect on women’s time; however, if incomes are greatly increased the women might not mind the added work. We will monitor this in the assessments of the 2004 farmer training workshop (Activity 1). We know from fieldwork Galvin conducted in July 2004 that camel herders do not separate coarse from fine camel hair because they say it is too time consuming. The only condition under which it occurs is when women want the fine hair for home use (usually in blanket making).

With the necessary assistance in know-how and marketing, Central Asian women can also learn how to process and sell locally produced wool. Liba Brent worked with a group of six families in the village of Uzumbulak in the Raimbek region of Kazakhstan to produce handspun yarn for export to the US.

The women were given spinning wheels, wool dyes, hand-carding machines, carding combs, and enamel pots for dyeing wool, and taught how to spin and dye Merino wool that is produced by the Arkhar Merino breeding farm in the Uzumbulak village.

The majority of the women are the wives of local shepherds, and migrate with their families between summer and winter pastures. Their shepherd families are paid \$100/month by the Uzumbulak sheep-breeding farm they work for. Their livelihoods would improve if they could subsidize their small income by selling handspun yarn in the course of the year. The women can spin yarn in their homes or yurts at the time of their convenience. Given that they do not have the opportunity to work outside of their house, homemade handicrafts such as yarn spinning can provide them with the perfect opportunity to generate additional income. The investment in the spinning wheels, dyes, and wool is relatively small, and the value of handspun, hand-dyed yarn on the American market is high – around \$20 for 150 yards. Many American knitters and weavers are interested in purchasing handspun yarn and at the same time supporting the livelihoods of pastoral women in Central Asia.

After a year of training, some of the Uzumbulak women learned how to produce quality, handspun Merino yarn that could be marketed to knitters in the United States. Liba Brent will seek additional funding to create a website for the women and advertise their yarn to yarn shops and non-profit organizations such as SERVV International, which assists artisans from around the world in marketing handicrafts. A detailed report on the activities of this project component will be provided.

POLICY

The project has been able to raise donor attention to the potential for cashmere market development in Central Asia. USAID Central Asia is now aware of the potential for cashmere to improve rural livelihoods – especially among the poorest and most remote farmers - in Kyrgyzstan and Kazakhstan. As a result, USAID is now outlining plans for new regional projects and training on cashmere. The USAID Farmer-to-Farmer program is designing

projects on cashmere farmer training and market development in Kazakhstan and Kyrgyzstan, as a result of meetings in which GL CRSP project results were conveyed.

The World Bank rural development office in Kazakhstan has noted that cashmere is an important commodity for the livestock sector in Kazakhstan. The new WB project with the Kazakh government on Agricultural Competitiveness, contains funding for activities on developing standards for laboratories and private investments into agro-processing that would include cashmere.

From the host governments' side, Kazakhstan regional officials in the target areas have expressed considerable enthusiasm for developing markets for farmers' cashmere sales. The Shieli district governor emphasized that Kazakhstan's President has charged local government staff with finding ways to improve the livelihoods of poorer farmers, and that selling cashmere was especially relevant for poorer livestock owners who are concentrating on keeping goats. This is in line with the Kazakh government's new policy, frequently stated by the country's President, of promoting investment into agro-processing and increasing value-added exports of agricultural commodities.

The Wisconsin team members informed policy-makers (i.e. local officials responsible for monitoring and assisting the sheep industry) about project activities in the pilot regions. The policy-makers showed interest in the project and support for our efforts to promote wool market development. They pointed towards the lack of governmental funding of the sheep industry, which prevented them from assisting sheep farmers in production and marketing. Our collaborator, Murat Otynshev, works for a governmental organization that seeks to develop a marketing infrastructure for different kinds of agricultural production, including wool. He has good connections to policy-makers, and will continue to inform them about our research and its policy implications.

The policy environment for market development of livestock products is changing, as national decision-makers have again recognized the economic contribution of these products to their countries. In Kazakhstan, the government has recently opted to

take a majority share-holding in the larger privatized wool processing and trading companies. The government therefore has a stake in the continued expansion and profitability of these markets. Results from the project's activities of providing training materials for producers as well as testing interest in market information centers and pools will also feed lessons learned into a current project by USAID/Almaty, which is piloting farm extension centers in other regions of Kazakhstan.

In Kyrgyzstan, the development of KSBA has been a major strategic choice by the government, and the government has borrowed \$12 million to date for the development of the sheep sector. Current development priorities stress the agricultural sector, and the new Poverty Reduction Strategy Paper stresses livestock development. The KSBA may well provide a model for institutional development of livestock producer organization's, which would be relevant also for Kazakhstan, where such organizations have not yet appeared.

According to Mr. Rakaev, general manager of KSBA and a Wool Project collaborator:

"From my point of view the GL CRSP Wool Project had affected very much policy making process in Kyrgyzstan in the fields of sheep industry. Kyrgyzstan, as well as other Central Asian Countries were under the former USSR and planned economy concept and mostly dependent on centralized supply of main assets, supplemental animal feeds and veterinary medicine. Also we had a certain role in centrally planned economy as a merino wool producing country and were mostly vertically integrated with former Soviet wool industry. Our wool industry was poorly integrated vertically and had to supply of raw or semi processed wool to Russia. Existing wool processing plants were very huge and designed to process wool even from southern regions of Kazakhstan and other Central Asian Countries. Modern wool and textile plants were located on European part of former USSR. Supplied wool to Russia was used mainly for military purposes.

"After the gaining Independence in 1991, Kyrgyzstan lost their market for wool and sheep products and as a result started restructuring the

agricultural industry within Kyrgyzstan. Also in 1991 the world had an oversupply of wool. The old soviet strategy with planned centralized system had other difficulties such as old scientific supply and education. These factors influenced the decline of the sheep population and spread of poverty in rural areas.

"As a result Kyrgyzstan was faced with numerous difficulties within the sheep industry. With the demise of the Russian and Kyrgyz run farms, the sheep industry caused other environmental problem like overgrazing of pastures located near villages and non use of remote pastures. Today with the help of the Wool Project, we had our own strategy which is based on our nomadic experience and natural resources and possibilities to trade with China, who is world leader in wool and textile.

"We prepared our own Sheep strategy and presented this strategy to the Ministry of Agriculture staff and other stakeholders. We also participate in debates on the future wool strategies."

Mr. Rakaev was asked to become a member of Public Chamber on Agriculture, and on November 2006, will present to the Public Chamber Members the real situation around sheep industry, with the hopes of bringing the sheep industry situation to the attention of the President of Kyrgyzstan.

OUTREACH

Farmers are identified as the primary stakeholders targeted in this project. Activities described previously, as well as workshops, training sessions etc. are the means by which the goals of the project are being fulfilled. The Wool project organized a training workshop for thirty four farmers, wool sorters, traders and buyers at a wool-scouring plan in the city of Semipalatinsk from April 17 – 22, 2006. The project collaborators from the Quality Center of the KazRuno wool processing company worked as trainers. The workshop program included a presentation on wool testing, classing, and sorting standards used in Kazakhstan. The participants learned about a variety of wool measurements such as FD, length, and yield and how to use them to sort

dirty wool. They also learned about the formation of wool prices, and the effects of specific quality standards on price. All participants took part in practical training in wool sorting and grading.

A two-day farmer-training workshop on cashmere was conducted in the project area of Totugul district center, Kyrgyzstan. Forty participants from 13 villages attended. These participants owned a total of 803 goats. Other training materials included diagrams on the price variation of raw cashmere by quality, samples of different quality cashmere, which were distributed to workshop participants, and diagrams on how farmers can improve cashmere quality through breeding. Hands-on demonstrations with participants showed how to comb and grade cashmere.

A shearing school was held in the Bishkek region, 10 shearers from 5 regions of Kyrgyzstan participated, along with 10 students from the Kyrgyz Agricultural Academy, who observed. Upon completion of the shearing school, the shearing participants received shearing equipment so they would be able to return to their districts and start shearing sheep.

DEVELOPMENTAL IMPACT

Environmental impact and relevance.

Though the project objectives do not directly address this question, it has become clear that market development needs to reflect regional ecological variations in the region. Both countries span major climatic and topographic regions with resulting agro-ecological zones. During and before the Soviet period, different breeds of livestock species were adapted to the particular physical conditions of each zone. Thus, in the extensive deserts of southern Kazakhstan, the Karakul sheep and local breed of goat thrived in the past and continue to be the mainstay of livelihoods. In the better-watered mountain foothills and valleys of Kyrgyzstan and southern Kazakhstan, cross-bred Merino fine wool sheep were introduced to the Soviet state farms. Some of these are still retained though many are now crossed with local meat-type sheep breeds.

Agricultural sustainability. This project examines how livestock resources can be better exploited to meet new commercial demand as well as increase economic returns to producers. The results of this study will be of interest to two livestock development projects in Kyrgyzstan -- the World Bank sheep development project and the UK DFID project "Support to livelihoods in livestock producing communities." USAID does not presently fund livestock-focused projects in either country. Kazakhstan does not have any livestock development projects, despite the importance of rangelands as a national resource, the tradition of extensive livestock rearing, and the contribution of livestock to rural household economies. This project proposes measures for assisting producers, researchers, and the commercial sector to realize greater value from wools and fibers through the market. These measures could be implemented through government and donor-assisted projects in the future.

One of the Uzumbulak artisans, Nurdukhan Dzeke, spinning Merino yarn in front of her yurt. Photo by Liba Brent.



Contributions to U.S. agriculture. Information from this project could be used to determine to what extent the US small stock, wool, and cashmere industry (to the extent that they exist) could become interested in Central Asian livestock products and contribute to the CA breeding stock.

The project will contribute to increasing demand for U.S. technical expertise in this area, improving sources of raw material availability for U. S. wool and cashmere importers, increasing the potential of equipment sales by U.S. manufacturers of sheep, wool, goat and cashmere equipment and services, generating training opportunities and long term contacts among institutions, and promoting private sector relationships for wool and fiber testing facilities in the U.S. The project fits well within USAID priorities for the region and the academic strengths of the research institutions involved.

Contributions to host countries. The case of Mongolia demonstrates the possible benefits to the host countries of developing a successful wool and fiber market. Selling raw cashmere has become the major source of income for privatized herders in Mongolia, and Mongolia's raw cashmere production has risen by 70% propelled by a strong demand from China, the USA, and Europe. The Mongolian government has encouraged direct foreign investment and new technology.

The project will strengthen the international competitiveness of Central Asian wools and fibers by improving national fiber assessment capabilities and specialist training, strengthening market information flows between producers and a broader global commercial sector, and increasing producers' ability to offer higher quality products in demand from international markets. Marketing wools and fibers that are more attractive to buyers will have direct development relevance for producers who can expect to receive better prices and larger volume sales for their products, improving incomes. Each additional export of wool and fiber has a positive development impact on national accounts, and contributes to increasing agricultural productivity. The project will contribute to resource sustainability through its policy focus on the spatial analysis of markets and the resource base in surrounding producer regions.

OTHER CONTRIBUTIONS

Support for free markets and broad-based economic growth. For the past decade in Kazakh and Kyrgyz pastoralists have been disengaging from the state collective farms and establishing contact with new domestic markets for livestock. One of the most pressing questions for the future of the livestock industry in both countries is whether small flock owners will have the resources to continue as livestock keepers. Ecological location and market access are also crucial to the success of livestock enterprises in both countries.

Contributions to and compliance with Mission objectives. In so far as the mission is concerned with increasing the livelihood strategies of Central Asian households, this project goes a long way towards addressing how this might be done.

Concern for individuals. Throughout this project we have been concerned about individuals and households ability to increase their economic base.

Support for democracy. The fact that the peoples of Kazakhstan and Kyrgyzstan have to engage in the open market will enhance their interaction with market economies. This may have a positive impact on the movement toward democratic government.

Humanitarian assistance. Not applicable

LEVERAGED FUNDS AND LINKED PROJECTS

The total value for leveraged funds for the WOOL project during 2006 was \$800. The sources of those funds were as follows:

ST-Group, Train wood graders and sorters, 4/2006, \$800.

Leveraged funds for the Cashmere Component of the WOOL project are included in the following report.

TRAINING

Non-Degree Training

Sheep Sheering School training, May 24, 2006 in Kickikemin. Facilitated by Akylbek Rakaev. To present current techniques in handling wool at shearing that will add value to the fleece, i.e. remove some portions due to defects, added matter, ect. Attended by 34 participants (32 male and 4 female).

“The Secrets of Successful Preparation of Wool”- training seminar on wool sorting, testing, and grading, April 17-22, 2006 in Semipalatinsk. Facilitated by Assel Imasheva and Tursun Gapashevich. Attended by 32 participants (31 male and 1 female).

Cashmere combing, grading, and sorting school, March 19, 2006 in Toktogul, Kyrgystan. Facilitated by Hilary Redden and Akylbek Rakaev. To train farmers in cashmere combing, grading, and sorting. Attended by 40 participants (6 male and 34 female).

Advice training and advice on wool and cashmere fibers, March 21, 2006 in Bishkek, Kyrgystan. Facilitated by Hilary Redden and Akylbek Rakaev. To do advance fiber training. Attended by 12 participants (10 male and 2 female).

Advance training and advice on wool and cashmere fibers lecture, March 23, 2006 in Bishkek, Kyrgystan. Facilitated by Hilary Redden and Akylbek Rakaev. To educate in high quality fiber production from goats and cashmere fiber qualities. Attended by 30 participants (15 male and 15 female).

Advance training on wool and cashmere fibers, March 27, 2006 at the Technology University of Almaty, Kazakhstan. Facilitated by Hilary Redden. Attended by 16 participants (6 male and 10 female).

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PUBLICATIONS, ABSTRACTS AND PRESENTATIONS

No publications, abstracts or presentations were reported by this project.

FOOTNOTES

¹The Southern Kazakh region produces primarily coarse wool sheep.

²According to governmental statistics, 35.2% or 9,595 tons is fine wool, 10% or 2,736 tons is medium fine, 10.2% or 2,775 tons is medium coarse, and 44.6% or 12,179 tons is coarse.

³The plant, located in Kyrgyzstan, processes 3,000 tons of fine wool and exports production to Turkey, Spain and Russia. Other companies, including the wool scouring plant in Dzhambul, also

invested in wool processing equipment and plans to build a new factory in Kazakhstan.

⁴Private farms are most often family farms that were set up after privatization of sheep flocks and pastures that belonged to state farms. Most private farms were established between 1993-1999.

⁵Arguably the most important factor in meat quality and taste seem to be the grasses the sheep consume. For example, the Arkhar Merino sheep that graze on high mountain pastures of the Tian Shian mountain range produce meat that is famous for its taste.

⁶Although the sheep scientists who collected the core samples were asked to collect samples from all bales, many of them visited the farms when the elite and fist class flocks were being sheared and collected samples from bales with first grade wool.

⁷Tulubek Kasenov, a scientist from the Sheep Breeding Institute who works at the Almaty farm, imported Meat Merino rams from Germany and is crossbreeding them with Kazakh Finewool sheep at the Almaty farm. Given that the Meat Merino rams have wool around 26 micron, this may be affecting the average FD on the farm. The SD for the mixed private farms is also slightly higher than for all other farms except Uzumbulak.

⁸The Uzumbulak farm breeds the Arkhar Merino sheep and consistently shows a relatively high SD although the farm staff practices a very careful breeding selection. The higher SD may be due to the higher inconsistency of wool of the Arkhar Merino breed due to the genetics of the wild Arkhar sheep that was used to develop this breed.

⁹By the fall of 2006, the ST Group fiber laboratory installed air conditioning, and the staff acquired more experience with using the OFDA4000. The ST Group Company aspires to become a certified fiber testing lab in the future.

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DEVELOPING INSTITUTIONS AND CAPACITY FOR SHEEP AND FIBER MARKETING IN CENTRAL ASIA (WOOL): CASHMERE COMPONENT

NARRATIVE SUMMARY

Native domestic goats of Central Asia produce cashmere, a fine warm undercoat, with a high commercial value on international markets. In the Soviet period, new breeds were widely introduced, crossed from local cashmere goats with Angora goats. These produced a higher yielding but coarser fiber with low commercial value. However, local cashmere goats were retained in the more arid regions. Since the late 1990s, Chinese cashmere processing factories have purchased raw cashmere from Central Asian villagers.. Although initially prices paid to Central Asians for their raw product were very low in comparison with other countries, prices have risen as global demand for good quality cashmere exceeds supply. As a new commodity in Central Asia, research, extension and processing of cashmere is still at an early stage. This is in contrast to sheep wool which was a highly-developed agri-industry in the Soviet period and continues to dominate the attention of Central Asian livestock researchers and policy-makers.

The project has sought to strengthen the capacity of Kazakh and Kyrgyz producers, researchers and commercial companies to improve cashmere marketing. The aim has been to increase the value of cashmere to producers. Through field research, the project identified that:

- Goats have become a particularly important source of livelihood for poorer farmers in remote regions, after the collapse of Soviet state farms a decade ago. Households with few livestock tend to rely more on goats than sheep. Nationally, goat populations are rising faster than sheep numbers.
- Livestock farmers are unaware of changing world prices for cashmere and price differentials for

quality. They are therefore in an extremely weak bargaining position when selling to traders.

- Villagers do not bulk up their cashmere to sell collectively, but instead sell individually to itinerant traders, again at a disadvantage.
- Goats are usually sheared rather than the cashmere combed and the whole fleece sold to traders, who profit from hand-separating and re-selling the valuable inner cashmere fiber.
- Neither livestock farmers nor small-scale traders have the skills to sort raw cashmere into quality classes; the final buyers therefore are not prepared to pay premium prices and producers do not realise the full value of their product.

The project's activities on cashmere market development in 2005-2006 included:

- Testing 350 cashmere samples from flocks in 6 provinces of the main production regions of Kazakhstan, the semi-arid south and west.
- Promoting village-level cashmere marketing associations
- On-site training of Kazakh researchers on goats and cashmere
- Publishing information brochures, posters and articles in the local press on how to improve cashmere marketing.
- Production and screening of a second video for training farmers and traders
- Informal in-depth interviews with numerous livestock-owning households, cashmere traders, local and national level government officials, and representatives of donor agencies
- Creating links between the domestic cashmere commercial sector and international buyers in Europe and the USA.

- Leveraged funds for a regional Asian cashmere conference, with representatives from twelve producing countries and international commercial companies.
- Transferred knowledge gained in the GL CRSP WOOL project to Afghanistan to develop a cashmere testing and marketing project with DFID, USAID and World Bank support.

Narrative overview. The cashmere component has been targeted at:

- Remote semi-arid ecological zones where fine wool sheep are not kept
- Small-scale flock owners who depend more on goats than sheep

The main finding is that cashmere is a new commodity in the extensive livestock sector, in contrast to sheep wool which has a long history of marketing in both countries. Income from selling cashmere is particularly important for small flock-owners in the semi-arid zones where other income sources are extremely limited. World demand for fine (good quality) cashmere is strong, prices are high and rising, and we have found that fine cashmere is produced in southwest Kazakhstan. It is concluded that development of cashmere marketing will particularly benefit poorer livestock-owners.

The project component on cashmere had the objective to determine how the market value of cashmere could be raised, thereby providing an opportunity for rural households to boost their annual renewable income, as compared to slaughtering goats for sale or home use. Cashmere is annually harvested, has high value by weight and is already being sold by producers.

Wool and cashmere for the market are produced in geographically specific ecological regions. Fine wool merino-type sheep are restricted to the more favored higher precipitation mountains and foothills, while the vast semi-arid deserts and lowlands are mainly stocked with indigenous coarse-wooled meat breeds of sheep and cashmere-bearing goats. See Figure 1. The distribution historically reflects Soviet priorities for wool production, when new breeds of fine and semi-fine wool sheep were distributed to state farms in Kazakhstan and Kyrgyzstan¹. By the

end of the Soviet period, Kazakhstan had between 4-5 million fine wool merino sheep, but the majority - some 15 million - remained indigenous fat-rumped and fat-tailed breeds raised in the dry low productivity regions. These breeds have coarse dark wool with a very low market value.

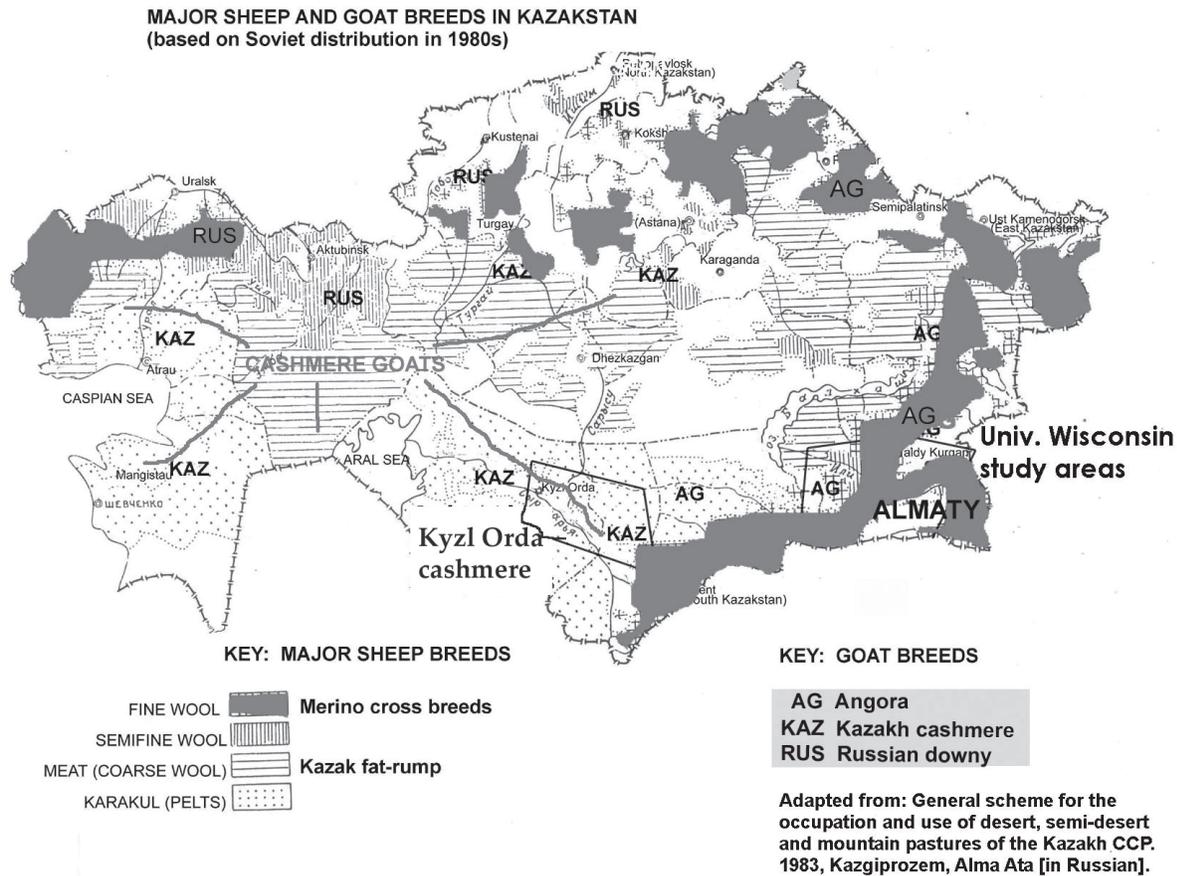
Due to the disastrous fall in post-Soviet sheep numbers in both countries, simultaneously with a fall in international wool prices and rise in domestic demand for meat, newly-privatized livestock keepers switched back to their traditional meat coarse-wool breeds. The ratio of fine wool to coarse wool sheep has declined, with the latter increasing in number. Fine wool sheep are now mainly kept by bigger private flock-owners and commercial companies, since having larger flocks, they can realize a profit from selling fine wool through economies of scale.

Keeping of local goats was strongly discouraged in the Soviet state farms, which introduced instead several new breeds of angora-type goats, whose fiber had an internal USSR market. In the post-Soviet period, many of the local goats - which produce cashmere - have been interbred with the angora-types, rendering the fiber of low commercial value. However, rising Chinese demand for cashmere in the past five years has resulted in a new market for local goat fiber from indigenous Kazakh and Kyrgyz goats, not crossed with Angora type goats. There are an estimated one million of these in Kazakhstan and some 0.7 million in Kyrgyzstan.

The project's aim for each commodity had an explicit focus. In the case of wool, there is an existing knowledge base in the form of skilled shepherds, technicians, researchers, previous market channels, processing factories and equipment (much of which has been replaced in the past decade). As both countries' livestock farms and processing factories were formerly geared to wool production, there was a firm foundation upon which to promote the project's goals.

In the case of cashmere, the project dealt with an entirely new commodity in the Central Asian context. There was virtually no local understanding of how to improve market value for this product. Shepherds never sold cashmere before half a decade ago; at the start of the project there were no technical facilities, processing factories and very

Figure 1. Sheep and goats by ecological region in Kazakhstan



little research capacity. Moreover, senior agricultural officials in the governments were not aware that local goats produced cashmere which was in demand internationally, let alone that in some regions, this commodity was of high quality by world standards. In this case, the project had a challenging task, but one in which progress has been made.

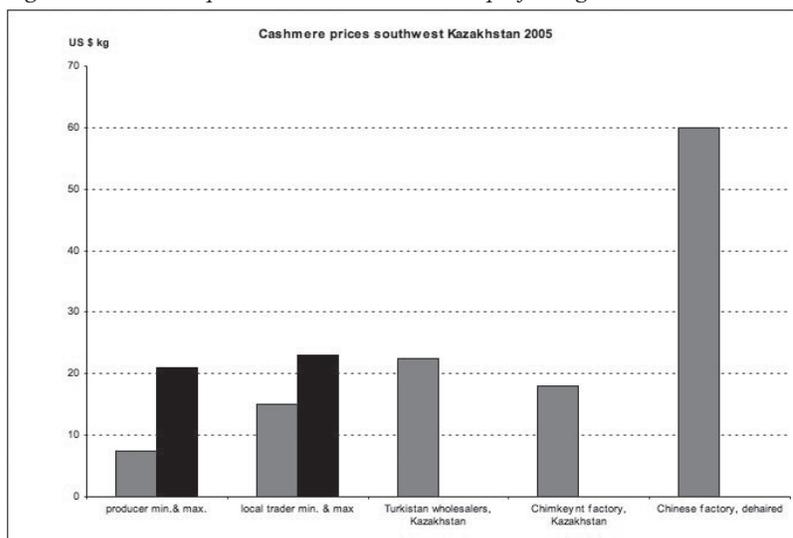
During 2004 in Kyrgyzstan, the official export value of cashmere (whole fleece and combed down) was 1.26 million dollars for a total of 855 tons. By comparison, the export value of sheep wool, which has a much higher profile as an agricultural commodity in Kyrgyzstan, was \$1.3 million dollars. Similar export data for Kazakhstan are not available. However, it is recognized that much cashmere leaves both countries unofficially for China and is therefore not recorded.

The cashmere activities aimed to promote combing, sorting and village group bulk marketing.

Cashmere has the potential to become an important farm income source particularly in the extensive semi-arid ecological zones which cannot sustain fine wool sheep and for which meat markets are inaccessible. Mongolian and western Chinese herders have benefited over the past decade from improved marketing of cashmere.

In the project area of Kyzl Orda province in southwest Kazakhstan, combed cashmere was selling at \$30 to \$40 per kg in spring 2006. The project established that the average weight of combed cashmere produced per local goat is 110 gm; the value per goat would therefore be \$3.30 to \$4.40. A poorer farmer owning only ten goats could expect to receive \$33 to \$44 for their cashmere, more than the market price for an adult goat in the district town of the target area. By contrast, the coarse dark wool produced by sheep in this region fetches only a few cents a kg and is often not sold at all.

Figure 2. Cashmere prices southwest Kazakhstan project region, 2005.



Prices for raw cashmere paid to producers in southwest regions of Kazakhstan continued to rise in 2006. This follows increased demand and competition among local buyers, as processors from China and Kazakhstan (including new processing factories opened in 2005) have realised that these regions produce high quality. Local large-scale traders have started to pay premium prices to producers for raw cashmere in regions where the highest quality is found. Middle-level traders pay local employees in Turkistan city to hand-sort the raw cashmere into rough grades of colour and quality. Figure 2 shows the price margins of raw and dehaired cashmere from southwest Kazakhstan. It can be seen that the most significant increase in value is after raw cashmere is dehaired (removal of rough outer hair), when the value trebles by weight sold from Kazakhstan to factories in China.

RESEARCH

Activity 1: Promoting Market Competitiveness in the Fiber Pipeline.

Problem statement and approach.

Objective 1: Provide market information on global prices and demand for cashmere to producers and traders in cashmere goat regions of Kazakhstan and Kyrgyzstan. Farmers

and local traders are generally unaware of the international price differentials by quality, so that they have little incentive to carry out on-farm combing and sorting by color and quality. Sorted raw cashmere is required to attract buyers willing to offer higher prices than currently offered for unsorted. There is only one buying period per year, beginning in March and ending in June. Therefore it is relevant to distribute market information in early spring before the buying season begins. This allows farmers

and traders time to respond to the market information by arranging to bulk their cashmere into sorted lots to obtain higher prices.

Progress. Several hundred market information brochures and posters on cashmere were distributed by Kazakh project partners to farmers and agricultural offices. They distributed these during their March 2006 trip to six provinces for collecting cashmere samples. Further brochures were distributed to traders in Turkistan city, and Zhane Kurgan and Shieli districts during April 2006

The second training video on combing and assessing cashmere was completed and shown to traders and farmers in two districts of Kyzl Orda province before the cashmere buying season began in April. The 17 minute video shows footage from the 2004 farmer training workshops in the Kyzl Orda project site. An explanation of cashmere prices in the world markets is also provided. The video commentary is in Russian, which is also used in Kyrgyzstan, with English subtitles.

An article in Russian was published in the Kazakh national journal "Agro-Inform" March 2006 issue, on "New opportunities for marketing cashmere". The journal has over 4,000 subscribers of which 75% are in the private sector and the remainder are government agricultural offices.

Fifty cashmere combs made by the Kazakh project partners were distributed to small-scale traders and farmers in April.

Objective 2: Assess impacts of farmer training workshops in Kyzl Orda province of Kazakhstan.

Four training workshops for farmers, local officials and traders had been provided in the first two years of the project, in two districts of Kyzl Orda province. The plan in Year 3 was to assess: whether producers obtained any price increase for their marketed cashmere following the workshops, whether producers adopted some of the husbandry practices recommended during the workshops, and whether traders have become more interested in purchasing cashmere from this region.

Interviews were also conducted with farmers and traders in other districts, who did not participate in the training sessions, in order to compare the relative price differentials received for fiber sold, if any, between those who attended the workshops and those who did not.

Progress. Qualitative interviews were conducted with farmers and traders in the target area districts as well as in a district of another province (South Kazakhstan) in which workshops had not been carried out, in Almaty (the principal commercial center), and in Turkistan city, the main trading center for cashmere in the nation.

The largest-scale trader in Shieli district said that there was an effect of the GL CRSP workshop there in April 2005. After the workshop, which took place before the buying season started, producers demanded higher prices when he sought to buy their goat fiber, as they told him they had learned at the GL CRSP workshop that their cashmere was expensive on the international market.

Interviews were also conducted with three district-level collectors of goat fiber in the two target districts and a village collector in one of the districts. None of these traders had been invited to the CRSP workshop in April 2005, though the district administration and project partners had been requested to ensure that local traders were invited. One trader commented that they do not have any connection with local government authorities as the latter “think about their own pockets”. The traders had learned about the workshop from the producers during the 2005 April-May buying season, who showed them the combs that the project distributed

and told the traders they had been taught how to comb goats.

All of the traders interviewed said that people did not comb the down off their goats for sale following the April 2005 workshop. Several producers were interviewed, who had tried to comb, but it was either too early in the season (prior to moulting) or too late, when most down had already moulted and been lost. The reason producers gave for why they did not comb was because the Turkistan wholesalers and their agents did not propose a higher price for combed down versus shorn fiber. However, the Turkistan wholesalers employ 100 women to hand-separate the coarse outer fiber from the down, and some sold this for \$18/kg to the new cashmere processing factory in Chimkeynt.

The mayor of one village who had attended the April 2005 workshop said that people in the villages got excited as they were told at the workshop that they had high quality cashmere goats, with similar value to Chinese cashmere. The mayor noted that the district administration was very interested in developing cashmere marketing as it brings new income for people. However, in his opinion the workshop should have been followed by practical steps of buying cashmere. The project invited the main national commercial buyer from the ST Group to the district in February 2006 to arrange buying of cashmere. However, the buyer sent his agent to the project region in April 2006 without a cash advance and when local traders had already purchased most of the season’s cashmere.

In order to compare the effectiveness of the project workshops in two districts of Kyzl Orda province (2004 and 2005), a separate visit was made to several villages and towns in Turkistan district, a cashmere-producing region in South Kazakhstan province, where no project activities have been undertaken. Producers were interviewed on their knowledge of cashmere combing and marketing. A number of local fiber traders in towns and villages were also consulted. Traders were keen to gain more information on how to sort cashmere and on differential prices by quality. None of the people interviewed had heard about the CRSP workshops in 2004 and 2005, in the adjoining province of Kyzl Orda. The villagers each own from a few goats

up to six hundred, and goats have been increasing in numbers faster than sheep, as they kid twice a year and often produce twins. One of the villagers interviewed had over 300 goats and many fewer sheep, as he said goats give an income from cashmere fiber as well as having a faster reproductive rate. He received a cash advance from the district trader in goat fiber to secure purchase of goat fiber at a pre-set price. Another villager interviewed had 20 goats and 4 sheep, and grew wheat and maize as well. A widow who was interviewed owned only goats and no sheep, and did not grow any crops. The only agricultural cash income she obtained in 2005 was from selling goat fiber to the local trader.

It was concluded that the farmer training workshops would have been more effective if commercial buyers of combed and sorted cashmere had been willing to pay premium prices for this, as discussed below.

Activity 2: Training on Fiber Quality Handling.

Objective 1: Promote group cooperative marketing.

Meetings with farmers, local administrators and traders were held to discuss how producers should sort their cashmere into grades and form village marketing cooperatives to sell in bulk at higher prices to large-scale buyers. The plan was to tie in with Activity 3 on finding new markets, as the project sought to secure purchasing arrangements between large-scale traders, possibly also international buyers, and local village groups. Progress on group marketing to large-scale buyers had already been made in Year 2, as the project has arranged with ST Group, a project partner and a large wool and textile company covering Kazakhstan and Kyrgyzstan, to purchase high-quality cashmere from village groups in the target Kyzl Orda region of Kazakhstan in spring 2006. This agreement resulted from having shown the company the test results on cashmere produced in this region, which was tested at the UK Fibre Lab.

One of the main lessons learned in the cashmere component is that villagers are unwilling to form cashmere marketing groups unless certain conditions are met. This may be termed the “Chicken and Egg Problem”. The project tried to encourage villagers

to form marketing associations in the cashmere target regions of Kyzl Orda province, with the aim that goat-owners would add value by combing and sorting cashmere and bulk up within villages to sell in larger lots, rather than shear the whole fiber and sell by individual households to traders, as currently practised.

The villagers and their leaders - both official and traditional - responded that they would not necessarily benefit from this at present. Local traders currently buy only sheared and unsorted whole goat fiber from villagers, rather than combed and sorted cashmere. Villagers said they would be more than happy to comb, sort and bulk up their cashmere if there were buyers prepared to offer them higher prices in advance for this product. But since traders very rarely ask for combed and sorted cashmere down, villagers are not willing to take the extra effort of preparing cashmere, in case they do not get a better price from traders, which would make this effort worthwhile. Local traders, on the other hand, privately stated very candidly that they make more profit buying sheared and unsorted goat fiber from individual villagers, and then crudely sorting and bulking it themselves before selling on to the next level in the marketing chain. The result is lost potential value to goat-owners, as combing cashmere generally increases value (fiber length is lost through shearing, which reduces value) and unsorted cashmere receives lower prices from processors.

This is the “Chicken and Egg” issue: until villagers can find guaranteed buyers for a higher-value product, they have no incentive, more risk and greater labor inputs by combing, sorting and bulking their cashmere. Meanwhile, large-scale traders seek to keep farm-gate prices as low as possible by purchasing undifferentiated raw material. Nevertheless, small-scale traders have started to appreciate that their profit margins are increased if they can buy and sell combed and sorted cashmere. Therefore, there is an opportunity in future to work with village producers and small-scale traders on ways to increase the value of cashmere.

Villagers suggested that if they can form associations and receive credit early in the cashmere season before buying begins, they would be able to comb, sort, bulk and sell their cashmere themselves.

This would considerably strengthen their bargaining power with large-scale wholesalers in the cities. Most small-scale village traders do not have sufficient cash to purchase cashmere in advance of the large-scale buyers; therefore small-scale traders have to depend on the larger-scale traders for cash advances and must therefore buy according to their requirements and prices.

Objective 2: Representative regional sampling of cashmere quality in areas previously identified as likely to have good quality indigenous cashmere goats in both host countries.

There has been no systematic data collected on the quality of cashmere available in different regions of either host country. This information is essential to attract foreign investment into processing cashmere domestically, as well as to facilitate high-value cashmere exports to international

processors wishing to obtain premium quality that is difficult to source. Previous GL CRSP research (Small Grants 2002-2003) found that Soviet breeding introduced angora-type goats that have now interbred with local

cashmere-producing goats. The crossbred goats produce “cashgora” for which there is a low international market value. However, laboratory tests on samples of goat fiber carried out in the first and second year of the project showed that some regions of southwest Kazakhstan had high quality fine cashmere, equal or better in quality to cashmere sold for considerably higher prices from Chinese and Mongolian goats.

The workplan was to collect 300 cashmere samples from farmers’ flocks in each host country in regions where angora goats had not previously been introduced. This was carried out in Kazakhstan, but not in Kyrgyzstan as funds were not available. Regions known to have a higher concentration of cashgora goats were not included in the sampling,

as the fiber will not be of sufficiently good quality to interest international buyers.

Since skills for laboratory testing of cashmere did not exist in Central Asia, the high cost of testing in a European lab (\$15 to \$25 per sample) meant that many fewer cashmere samples could be tested than for wool, which was tested at much lower cost per sample at wool laboratories in the host countries.

Progress. The Kazakh host country partners Berik Aryngaziev, Mukhan Nuraliev and Serik Aryngaziev undertook three field trips to collect cashmere samples in east, south and west Kazakhstan during March 2006. Berik Aryngaziev’s trip to four provinces covered 1,500 km by rail, a further 4,500 km by road and took three weeks.

The plan was to sample 6-8 individual goats in each of three farms within 20 districts in six provinces

(Oblasts). Samples were taken from adult female goats (aged 1 year and older) while at least one adult male was also sampled in each village (37 males total). Table 1 shows the distribution of samples collected.

These samples were assessed by two methods: a subjective assessment of quality, color and yield (Table 2) and objective tests of fiber diameter using an OFDA 100, shown in Tables 3 and 4. Assessments were carried out by project partner Hilary Redden, at The Fibre Lab, Aberdeen UK.

Cashmere diameter (in microns or μm) is the international standard for assessing quality. Below 16.5 micron is termed “hosiery” and has the highest value as the best quality demanded by processors. Diameters between 16.5 and 18.5 micron are termed “weaving” and are also often bought by processors but at lower prices. Above 18.5 micron is not considered cashmere internationally. The results indicate that Kyzl Orda province has mainly high quality cashmere goats. The northwest provinces

Table 1. Kazakh cashmere samples collected in March 2006

Oblast/ Province	No. districts	No. villages	No. farms	No. samples
Aktube	4	5	5	34
Atyrau	2	2	2	16
West Kazakh	3	4	4	32
Kyzl Orda	4	12	13	82
South Kazakh	5	12	13	94
Almaty	1	3	3	17
Total	19	38	40	275

Table 2. Diameter of goat fiber samples from south and west Kazakhstan, 2006 (subjective assessments).

Oblast/ Province	Hosiery % less 16.5 micron	Weaving % 16.6 -18.5 micron	Cashgora % too coarse	No. samples
Kyzl Orda	85	11	4	82
South Kazakh	65	17	18	94
Almaty	47	41	12	17
West Kazakh	47	37.5	15.5	32
Aktube	23.5	35	41	34
Atyray	25	12.5	62.5	16
TOTAL %	60.5	21	18.5	275

of Aktube and Atyray have another goat breed introduced in the Soviet period, the Orenburg, which has different characteristics to the local Kazakh cashmere goat. This probably accounts for the coarser and cashgora-type characteristics of samples from these two regions. Almaty province has a lot of angora-type goats, with coarser fiber. Some South Kazakhstan districts also had angora goats introduced in the Soviet period.

For objective measurements, every second sample was taken from West Kazakhstan, Kyzl Orda, South Kazakhstan and Almaty Oblasts (129 total). Additionally, the best samples previously visually assessed from Aktube and Atyray Oblasts were selected, as the poorer samples from these provinces were obviously too coarse and would have been above the commercially acceptable upper limit for cashmere of a mean fibre diameter at 18.5 micron (see Table 2).

The samples were not dehaired and contained both the cashmere and guard hair component in the sample. Fibre diameter measurements were made of the cashmere component from the subset of 129 samples. The range of fibre diameters selected was from 4-30 μm (microns). This range was selected as best describing the cashmere component of the sample and used guidelines set by the European Fine Fibre Network (1998).

Samples were given a 3 bowl aqueous scour to remove animal grease and soil, dried, then measured using an Optical Fibre Diameter Analyser (OFDA100) set to measure all recognised fibres between 4 and 30 micron. Between 10,979 and 1,131 individual fibres were measured for each sample.

A summary of results by Oblast and sex of goat is given in Table 3.

Mean fibre diameter for Aktube Oblast is 17.3 μm but within the Oblast, it can be seen that there are animals with a desirable mean fibre diameter of 15.7 μm . The mean fibre diameter of 16.1 μm for Atyray Oblast is within the definition of hosiery (fine) quality cashmere. West Kazakhstan although showing a mean cashmere diameter of 17.3 μm , has an even distribution of cashmere around this diameter between the regions. The exception was one animal in Birlik village with a desirable, fine,

Table 3. Maximum micron, minimum micron and mean fibre diameter micron, standard deviation μm and coefficient of variation (%) of the cashmere portions (4-30 micron) of fibre samples from Kazakhstan goats by province and sex of goat

OBLAST (Province)	No.	Diameter			Standard Deviation			Coefficient of Variation %		
		Max	Min	Mean	Max	Min	Mean	Max	Min	Mean
Aktube	10	20.3	14.7	17.3	5.2	3.2	3.9	26.4	20.3	22.4
Atyray	6	17.9	14.8	16.1	3.7	3.1	3.3	21.8	17.7	20.7
West Kazakh	16	19.0	14.9	17.3	4.7	3.2	3.7	27.2	18.4	21.5
Kyzl-Orda	41	17.0	12.4	15.4	4.0	2.8	3.3	24.6	19.3	21.7
South Kazakh	47	20.6	14.0	16.7	4.6	2.9	3.5	24.9	17.7	21.2
Almaty	9	19.4	15.8	17.1	4.1	2.9	3.5	23.4	18.0	20.7
Overall	129	na	na	16.4	na	na	3.5	na	na	21.4
Female	111	20.6	13.1	16.5	5.2	2.8	3.6	27.2	17.7	21.5
Male	18	19.1	12.4	15.7	3.8	2.8	3.3	24.1	17.7	21.2

mean cashmere diameter of 14.9 μm . In Kyzl Orda Oblast, the mean cashmere diameter of 15.4 μm is within the preferred cashmere diameter range favoured by high quality textile manufacturers. Within the four sampled districts of Kyzl Orda, Syr Darya district had a mean of 14.9 micron (10 samples) and Terenozek had a mean of 15.1 micron (10 samples). Over the whole sample, the lowest overall cashmere fibre diameter of 12.4 μm was found in Terenozek district in Chagan village of Kyzl Orda Oblast. In South Kazakhstan, the districts of Kazgyrt and Baidabek have coarser quality cashmere compared to Ordabasu, Otyra and Syrdarya districts, which have desirable hosiery quality cashmere. In Almaty Oblast, although the cashmere mean was 17.1 μm , there were individual animals with hosiery quality cashmere to be found.

The standard deviations and coefficients of variation indicated that although some individual animals had highly variable fibre diameters within their coat, the general variability of fibre diameter as indicated by the coefficient of variation was relatively low. This is a desirable quality as it makes yarns and fabrics made from such fibres more consistent.

Cashmere quality varies between Oblasts (provinces) and districts, and from very coarse (would not normally be considered true commercial quality) cashmere and very fine, highly desirable cashmere. Therefore, if selective collection of cashmere from Oblasts and districts was carried out, commercially-attractive quantities of specific cashmere types and mean fibre diameters would be possible. Specific cashmere lots (identified by mean fibre diameter and fibre length) would be more attractive to textile processors as the yield, type of yarn and finished fabric are more predictable and repeatable from year to year.

It is interesting to note that the mean cashmere diameter of the males tested is less than the females, although generally cashmere from adult male goats is coarser than females. The lower diameter from sampled males is possibly because the average age of males in flocks tends to be younger than the average age of females, as only a few adult males are retained for breeding in village flocks. Younger goats usually have finer cashmere. It means that there are some very good quality male goats available within

the national flock. During the sampling, farmers' individual names were recorded, as well as the village and district, so flocks with the best quality cashmere could be identified for any future breed improvement program.

As a comparison between testing regimes and equipment, 15 separate cashmere samples were collected in the Kyzl Orda target area in February and tested on an OFDA100 by the Fibre Lab UK and an OFDA4000 by the new ST Group laboratory in Almaty. There was a one micron difference in the results; statistical tests (T test paired two sample and ANOVA) showed these differences to be significant. The OFDA at the ST Group lab has since been recalibrated.

Weights of combed cashmere were assessed from the Mynbaevo Institute -British Embassy goat flock, from 50 adult goats originally purchased from three provinces including Kyzl Orda. The average weight was 101 gm, ranging from 44-272 gm. In the project target area of Kyzl Orda province, combed cashmere from 24 different goats was weighed, giving an average per goat of 110 grams, ranging from 44 to 265 grams. The quantity of cashmere per goat in local Kazakh breeds has not been assessed since the 1980s².

Training was provided to the junior project partners on combing, data recording and labelling the cashmere. Principles were explained for selecting the best-quality goats for breeding. The junior project partners have no previous experience or training in selection.

Activity 3: Finding New Market Options: From Producer to Processor.

Objective 1: To find new marketing options for cashmere producers and processors in Kazakhstan and Kyrgyzstan. Inform international and domestic buyers of the quality and quantity of cashmere available. Based on information from the Mongolian study tour in June 2005, it is known that Mongolian and European buyers are prepared to pay premium prices for high quality cashmere. By contrast, Chinese buyers currently purchase unsorted raw cashmere from Central Asian producers at a

uniform price regardless of quality. In Kazakhstan the quality of cashmere varies considerably by region, and this is likely to be the case in Kyrgyzstan. Cashmere processors require detailed and objective information on the quality and quantity of raw sources available, as well as to inspect small samples, prior to reaching any decisions regarding purchase. International companies which are considering investment into Central Asian factories for processing raw cashmere also require objective information and guidance on the investment climate. This activity therefore had a twofold role: (1) Liaison with companies (both domestic and international) that wish to gain information on quality and quantity of cashmere available and (2) maintaining contact with international companies that are interested in investing in processing factories within the host countries.

Progress. Results of the regional sample tests of Kazakh cashmere (Activity 2) were made available to domestic and international companies that expressed interest in either importing raw cashmere or investing in processing facilities in the host countries. These companies included an Italian firm, Cariaggi Lanificio Spa, and two British firms, Cashmere International and Seal International. A selection of 15 cashmere samples from Kyzyl Orda goats in Kazakhstan was sent to each company for their assessment. One of the companies responded that the quality of samples was high and the company wished to discuss prices and export through a Kazakh organisation. This was arranged by the project through contacts with Kazakhstan's main cashmere exporters and owners of the new cashmere dehairing plant that opened in 2005.

Discussions were held in March 2006 with a fashion house, "Katharine Hamnett" (London, Hong Kong), a pioneer in ethical clothing. The company is seeking an alternative source from China to purchase fine quality cashmere for a new fashion line, using cashmere produced by family farms using environmentally-safe methods.

Agreement was reached in October 2005 with ST Group, project partner at the large commercial textile company operating in Kazakhstan and

Kyrgyzstan, to arrange sorted and bulked cashmere purchases from the project target area at premium prices in spring 2006. However, buyers sent by ST Group did not have cash advances to pay producers, which are offered by all local traders in the region, and therefore were not able to purchase cashmere in the buying season.

Murat Otynshev, GL CRSP project partner and a director of Semtex (ST) textile company in Kazakhstan and Kyrgyzstan, set up cashmere dehairing facilities in 2006 at the Kasiet textile mill in Tokmok, Kyrgyzstan. This followed from his participation in the June 2005 study tour on Mongolia's cashmere industry (with leveraged funds from the British Embassy Kazakhstan). As a consequence of this trip to Mongolia, he had business contacts with Mongolian companies that are interested in buying processed cashmere yarn produced by the ST company in Kazakhstan/Kyrgyzstan. At several international meetings he attended, he promoted the quality of Kazakhstan raw cashmere available.

Several publications described the quality of cashmere available in the host countries (see "Publications") to attract international buyers.

Objective 2: Regional meeting of representatives from cashmere-producing countries. Leveraged funding has been obtained from three additional sources to host a meeting of the Asian countries that supply cashmere to China. The main sponsor is the UK Government's Department for International Development (DFID) through the Central Asia desk, London. Support will be provided by the largest wool and animal fibre processing company in Kazakhstan and Kyrgyzstan, ST Group Company. The World Initiative for Sustainable Pastoralism (WISP) funded by UNDP and the International Union for Conservation of Nature (IUCN) is also a sponsor.

The meeting is planned for January 2007 in Bishkek, Kyrgyzstan, re-scheduled from September 2006 while awaiting confirmation of funding sources. The local organizer is the project's host country partner, Akylbek Rakaev, Director of the Kyrgyz Sheep and Goat Breeders' Association.

Invitations have been issued to representatives of

the cashmere research and commercial sectors of the following countries: Afghanistan, Australia, Germany, India, Iran, Kazakhstan, Kenya, Kyrgyzstan, Japan, Mongolia, Pakistan, Switzerland, Tibet, Tajikistan, Turkmenistan, Uzbekistan, UK and USA.

The purpose of the meeting will be to address common issues for these supplier countries that arise from China's increasing domination of cashmere production, processing and export. One theme of the meeting will be identifying alternative and more profitable sales channels for cashmere produced outside of China. Other themes will be standardization of quality measures between countries, exchange of information on processing technology, comparison of prices received from processors, and discussion of on-going cashmere research and development projects.

GENDER

In-depth village interviews have not found any negative gender bias towards the project's activities and objectives. In fact, if the project goals are met, this will enhance the economic role of rural women without creating additional labor requirements or reinforcing existing gender inequalities.

Kazak and Kyrgyz women, in common with women in other parts of Central Asia, have traditionally processed livestock fiber products from sheep, goats and camels into homemade articles such as carpets and clothing.

Sometimes these articles are sold in villages or urban markets by women and provide a much-needed source of cash income. In handling wools and fibers, women comb, clean, sort, card, spin, weave and knit, as well as make felt and knotted carpets. When male household heads are interviewed about production and sales of wool, cashmere and camel hair, they frequently refer to their wives for accurate information, which rarely occurs in the case of other household livestock management questions.

One of the key project goals has to train producers to sort their raw cashmere into quality classes, thereby increasing the price which they can expect when selling to traders. Since women are recognized within the rural society as having specialized knowledge and abilities in handling

animal fibers, achieving this goal will raise the status of women by yielding more income to their families. Whereas currently it is usually the male heads of household who sell unsorted wool or cashmere to traders, they are beginning to realize that selling unsorted products lowers the price.

Since Central Asian women are knowledgeable about and interested in animal fibers, they were a focus of our efforts to improve marketability of cashmere. They have shown great interest and participated in the cashmere farmer training workshops, though it sometimes has been difficult to obtain their equal participation, as workshop organizers are male and tend to invite men and overlook women.

POLICY

The project has increased the awareness of Central Asian government officials, livestock researchers and donor organisations of the potential for improved marketing of cashmere in Kazakhstan and Kyrgyzstan to increase the incomes of livestock keepers. This has been achieved through local language publications in the national press, meetings and discussions, the study tour to Mongolia in 2005, and English –language Research Briefs by the GL CRSP program which have been distributed to key personnel in donor organisations.

The project partner, Prof. Serik Aryngaziev, Deputy Director of the Mynbaevo Sheep Breeding Institute, has briefed the Kazakhstan Ministry of Agriculture several times about the prospects for developing cashmere. The Director of the Kazakh Institute for Livestock, Pasture and Veterinary Research has indicated his support for cashmere research as a new topic in the Institute. The World Bank in Kazakhstan has expressed interest in including a cashmere component in a new rural development project in Kyzl Orda province, as a result of publications and submissions from the project. The Kazakhstan World Bank Rural Development officer has met several times with the Head of Livestock Dept in the Kazakh Ministry of Agriculture to discuss promotion of cashmere production and marketing. In the rural areas, the governors of both target districts in Kyzl Orda have expressed their intention to encourage cashmere

marketing as a means to address rural poverty through livestock development.

In Kyrgyzstan, the USAID office is designing an agricultural project that is likely to include a cashmere component, and will support several Kyrgyz participants to attend the project's regional Asian cashmere meeting in January 2007. The British Embassy (Kazakhstan and Kyrgyzstan) and DFID (London) are providing the bulk of funding for this meeting to be held in Bishkek, Kyrgyzstan. The USAID-funded AgFin+ project in southern Kyrgyzstan developed cashmere marketing activities based on the project's findings in Kazakhstan.

Further afield, approaches and findings from this project have had a direct application in Afghanistan. In 2006, a project was designed by Carol Kerven to collect 600 cashmere samples from 10 provinces in Afghanistan; these were tested in the UK by project partner Hilary Redden at the Fibre Lab. That project also included an assessment of market potential for Afghan cashmere and recommendations for its development. DFID, USAID, Aga Khan Foundation and FAO (UN) co-funded the projects that contributed to this cashmere assessment. The World Bank is designing a livestock project in Afghanistan that will have a cashmere component and make use of the assessment findings. DFID is funding a rural livelihoods project in Afghanistan that will include training for cashmere production and marketing, as a result of the assessments.

OUTREACH

The cashmere component has provided market information and training to villagers, traders and local officials, and has distributed information to donor and commercial organisations, as described for Activities 1 and 3. Further outreach will be achieved in the planned regional Asian cashmere meeting, in January 2007.

DEVELOPMENTAL IMPACT

Environmental impact and relevance. The project activities on cashmere marketing do not have any discernable environmental impact but an increasing interest among villagers for keeping goats

could exacerbate overgrazing around villages. Field research in the project target areas for cashmere has found that as village livestock populations are rising, more people are moving their animals away from the villages for seasonal grazing. This is a positive environmental development, to be encouraged in future projects and government policy.

Agricultural sustainability. Much of the rural population of Kazakhstan and Kyrgyzstan is highly reliant on livestock. According to the International Livestock Research Institute³, in 2001 Kazakhstan had some 4.7 million households that mainly depend on livestock, while Kyrgyzstan has around 0.8 million. This means that about one third and one-fifth respectively of the populations are livestock-dependent. These figures are likely to have since risen, as livestock numbers have increased in both countries. Most of the household income from these animals is currently derived from their sale for meat and home consumption of meat and dairy products. Since harvesting of cashmere brings a sustainable annual income, better cashmere marketing will diversify income sources. This applies especially in the marginal geographical regions where opportunities for other agricultural incomes are limited by aridity, altitude and lack of irrigation.

The relatively sharp increase in goat populations in Kazakhstan and Kyrgyzstan is connected to the dramatic loss of sheep in the mid 1990s, when state livestock farms were rapidly dissolved and state subsidies to the livestock sector ceased. As sheep were bartered away in the economic crisis of this period, they became scarce, expensive and thus unobtainable for the many newly-poor villagers who had suddenly lost their jobs in the state organisations. Poorer households started to keep goats as an alternative to sheep. As a Kazakh expression states, "If you are really starving, you have to keep goats". By 1997 and 1998, when the national sheep numbers reached their lowest point, goat numbers began to rise and have continued to grow.

Contributions to U.S. agriculture. USA companies and organisations involved in cashmere production and marketing have been alerted to the quality and availability of cashmere in Kazakhstan and Kyrgyzstan through an article published in the US trade magazine "WildFibers" in Fall 2005.

Several commercial enquiries from US businesses were received as a result of this article.

Contributions to host countries. Research undertaken by the project has revealed that enabling livestock-owners to realize the full value of their cashmere output requires development of missing elements in the marketing chain:

- Updating national researchers and extension agents on international cashmere standards and assessment methods
- Developing livestock farmers' capacity to harvest cashmere and assess according to quality
- Disseminating market information flow and improving connections to international markets
- Supporting farmer marketing associations
- Upgrading and standardizing goat breeds, and improving farmers' breeding selection criteria and goat husbandry

These messages have been widely distributed to researchers and policy-makers in the host countries; as a result, a number of new projects are planning to include cashmere development activities, as described in Section 6 "Policy".

Linkages and networking. Linkages and networking have been expanded to the wider Asian region of cashmere-supplying countries through the project's regional meeting in Kyrgyzstan, planned for January 2007. Contacts have been established with research and donor organisations working on cashmere in the following countries: Afghanistan, Australia, Germany, India, Iran, Mongolia, Nepal, Pakistan, Tibet (PRC), Tajikistan, Turkmenistan, Uzbekistan. Contacts with commercial companies have been established in Japan, Italy, Switzerland, UK and USA. Representatives from these countries have been invited to the regional meeting. Two international research organisations (IARCS) have assisted with identifying representatives to the meeting: ILRI (New Delhi, Asia office) and ICIMOD (Nepal). The World Initiative for Sustainable Pastoralism (UNDP and IUCN) is one of the funders of this meeting.

OTHER CONTRIBUTIONS

Support for free markets and broad-based economic growth. The project's cashmere component has collaborated with host country private sector agri-businesses engaged in trading and processing cashmere. Training, information and advice has been given to small and large businesses in this cashmere sub-sector. Contacts between these companies and international firms have also been established. The project has collected data on national enterprises that trade, process and export cashmere from Kazakhstan and these data have been made available to the World Bank, DFID and USAID regional offices.

Concern for individuals. The cashmere component has worked with individuals in the host countries, as project partners, researchers, lab technicians, traders, business people, local officials and villagers. On-the-job training has been provided to young Kazakh researchers.

Contributions to and compliance with Mission objectives. USAID mission objectives to support new and diversified income options for rural people in Central Asia have been addressed through discussions with the Central Asian Regional Agricultural Officer, the Regional Private Enterprise Officer, the USAID head of Mission in Kyrgyzstan, and the Chief of Party for the USAID AgFin+ project in Kyrgyzstan. The cashmere component has provided publications, proposals and information to all these officers.

Support for democracy. The targeted desert ecological regions for cashmere market development are among the most economically disadvantaged in Kazakhstan. According to UNDP Human Development indices, these semi-arid regions are classified as "low potential", with higher proportions of people living below the poverty line and lower per capita incomes, than other better-favoured regions. The desert villages receive little assistance from the state, due to their low population density, remoteness and little obvious capacity for generating wealth. The villagers therefore welcome the efforts of project partners in the Kazakh research team, to raise awareness of market opportunities for cashmere. The district government officials also

appreciate these efforts to secure better prices for a locally-produced commodity for which there is world demand. An effect of the cashmere training and information activities has been to foster a greater sense of inclusion among villagers and small-scale traders, that they can participate in wider national and global markets.

Humanitarian assistance. The cashmere component is particularly applicable to poorer households that are food-insecure, as previous research by the project has identified these households as more likely to own goats than other livestock species, and to depend more on goats for basic subsistence and cash needs.

LEVERAGED FUNDS AND LINKED PROJECTS

The UK government Department for International Development (DFID) has contributed \$32,000 towards holding a regional Asian cashmere meeting in Bishkek, Kyrgyzstan, January 2007.

The World Initiative for Sustainable Pastoralism (UNDP and IUCN) will contribute approximately \$10,000 to support two Asian representatives to attend this meeting.

Two USAID-funded projects “Kyrgyz Agro Input Development Enterprise” and “Batken and Sugd Agro-Input Dairy Development Project (Tajikistan) will contribute funds for three Kyrgyz/Tajik participants to the regional meeting.

ST Textile Group Company (Kazakhstan and Kyrgyzstan) will contribute in-kind materials and a venue for the meeting.

A NATO Advanced Research Workshop held in Bishkek covered Kerven’s travel costs (approximately \$3,000) from UK to Kazakhstan to participate in the EEP review of the WOOL project in May 2006.

A National Science Foundation (USA) grant to Colorado State University covered Kerven’s trip costs (approximately \$3,000) to Kazakhstan in October 2005, which included working on this GL CRSP project.

Leveraged funds of \$50,000 were obtained for a cashmere assessment and training project in Afghanistan. The project was funded by the UK Dept. for International Development (DFID) and

FAO (UN); coordinated by the USAID-funded Rebuilding Agricultural Markets Program (RAMP) in Afghanistan. Methods and findings from this GL CRSP project were applied. There are now commercial links on cashmere processing and marketing between Afghanistan and Kazakhstan, through the private sectors.

PUBLICATIONS

Kerven, C. and Smailov, A. Video: “Training on cashmere combing and sorting”, in Russian with English subtitles. 20 minutes. May 2006

Kerven, C. and Smailov, A. “Goat down for profit”, 4 page colour brochure in Russian. 800 copies distributed farmers, traders, officials and donors in Kazakhstan and Kyrgyzstan in March 2006.

Kerven, C., Aryngaziev, B., Redden, H. and Smailov, A. 2006. Cashmere in Kazakhstan: A marketing update”. Global Livestock Collaborative Research Support Program Research Brief 06-01-WOOL.

Kerven, C., H. Redden, S. Aryngaziev. Fine cashmere available in Kazakhstan and Kyrgyzstan. Wild Fibres (Maine USA), Fall 2005 (pp 8-13).

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WOOL April 2005.

ABSTRACTS AND PRESENTATIONS

Kerven, C. Presentation on 'Livestock and Pastoralism in Kyrgyzstan: Social and Economic Implications' at conference on Kyrgyzstan at the Crossroads, St. Anthony's College, Oxford University, UK, 3-4 March 2006.

Kerven, C. Presentation on 'Integration of Central Asian Pastoralists into World Cashmere Markets: Opportunities for Improving Livelihoods and Adding Value' at Conference on Pastoralists and the World Market: History, Problems and Perspectives. University of Leipzig, Halle-Wittenberg, Germany, 27-29 April 2006.

Kerven, C. Presentations on (1) "Introduction to Cashmere Production: Global and Regional Perspectives and Economic Potential"

(2) "Cashmere Production in Afghanistan: An alternative livelihoods option?" for DFID project "Support to Strategic Planning for Sustainable Rural Livelihoods" Afghanistan Ministry of Agriculture, Kabul, Oct 2006.

Kerven, C. Presentation "Improving markets for Afghan cashmere producers: Learning from the Central Asian experience" for DFID project "Support to Strategic Planning for Sustainable Rural Livelihoods" Afghanistan Ministry of Agriculture, Animal Husbandry and Food and USAID "Rebuilding Agricultural Markets Program" (USAID), Ministry of Frontiers and Tribal Affairs, Kabul, Afghanistan, March 2006.

Award

The Director of the Scientific Centre for Livestock, Pasture and Veterinary Research in Kazakhstan expressed his appreciation for the collaborative work carried out on cashmere by the GL CRSP project with his Centre. He noted the development of cashmere goats in Kazakhstan had potential for increasing incomes from livestock. He presented Carol Kerven with an honorary official award (Gramatica) from the Kazakhstan Ministry of Agriculture, for "Contribution to scientific research

on problems of developing extensive pasture-based livestock production in Kazakhstan".

Training and Collaborating Personnel are reported in the previous section.

FOOTNOTES

¹Plan of breeding sheep in Kazakstan, approved by Ministry of Agriculture 1986. Source: Asian Development Bank (Kazakstan) 1997. Wool marketing and production: From setback to new growth. Abt Associates, Washington D.C).

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²Aryngaziev, S. 1998a. Downy goats in Kazakstan. European Fine Fibre Network No. 3, Macaulay Land Use Research Institute, Aberdeen.

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³ILRI 2002. Mapping Poverty and Livestock in the Developing World, Table 3a. P. Thornton et al. editors. Nairobi.

PRINCIPAL INVESTIGATOR FOR CASHMERE COMPONENT

Carol Kerven, Research Associate, The Macaulay Institute, United Kingdom. Consultant to University of Wyoming and to the GL-CRSP, University of California, Davis. Anthropology, PhD. Email: Kerven_Behnke@compuserve.com.

GLOSSARY

A-AARNET	ASARECA Animal Agriculture Research Network
ACDI	Agricultural Cooperative Development International
ADB	African Development Bank
ADRA	Adventist Development and Relief Agency Canada
AFD	Action for Development
AFS	Avian Flu School, GL-CRSP Project
AGWA	Automated Geospatial Watershed Assessment
AHEAD	Animal Health for the Environment and Development, WCS Programme
ALIN	Arid Lands Information Network
ALRMP	Arid Lands Resource Management Project
AID	Agency for International Development, Washington D.C., USA
AIDS	Acquired Immune Deficiency Syndrome
ALRMP	Arid Lands Resource Management Project
AMPATH	Academic Model for Prevention and Treatment of HIV/AIDS
AMREF	African Medical Research Foundation
APDA	Afar Pastoral Development Association
AR	Action Research
ARV	Anti-retroviral Treatment
ASAL	Arid and Semi-Arid Land
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
ASCE	American Society of Civil Engineers
ASF	Animal Source Foods
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
ASTM	American Society for Testing and Materials
ATIRI	Agricultural Technology and Information Response Initiative
AU/IBAR	African Union/Inter-African Bureau for Animal Resources
BASIS CRSP	Broadening Access and Strengthening Market Input Systems Collaborative Research Support Program

BEEF	Beef as a source of vitamin B-12, iron, and zinc to improve development of infants fed low levels of animal products, GL-CRSP Project
BLPDP	Borana Lowlands Pastoral Development Project
BIOMAP	Biological Monitoring and Assessment Program
BIOMAT	Biological Monitoring and Assessment Tool
BLM	Bureau of Land Management
BTB	Bovine tuberculosis
CAHNET	Community Animal Health Network
CAP	Community Action Plan
CARE	Cooperative for American Remittance to Europe, Inc.
CBO	Community-based organization
CGIAR	Consultative Group for International Agricultural Development
CHPS	Community Health Promotion Service
CIC	Community Information Centers, Ethiopia
CIDA	Canadian International Development Agency
CIFA	Community Initiatives Facilitation and Assistance
CMO	Crisis Mitigation Office
CMORPH	Climate Prediction Center Morphing Method
CNP	Child Nutrition Project, GL-CRSP
COSTECH	Tanzania Commission for Science and Technology
CRC	Conservation Resource Center, Tanzania
CRSP	Collaborative Research Support Program
CSA	Credit and Savings Association
CSA	Community Savings Association
CSA	Central Statistics Authority, Ethiopia
CSU	Colorado State University
DEM	Digital Elevation Model
DFID	Department for International Development, United Kingdom
DHMT	District Health Management Team, Kenya
DLPO	District Livestock Production Officer
DO	Dissolved Oxygen
DOM	Digestible Organic Matter
DOT	Directly Observed Treatment

DPFS	Dire Dawa Disaster Preparedness and Food Security, Ethiopia
DPPC	Drought Preparedness and Prevention Commission
DPPB	Disaster Preparedness Planning Board
EARO	Ethiopian Agricultural Research Organization
EEP	External Evaluation Panel
EGAT	Economic Growth and Trade
EU	Egerton University
FAO	Food and Agriculture Organization, United Nations
FAO FSAU	Food Security Assessment Unit
FARM-Africa	Food and Resource Management, Africa
FCI	Forage Condition Index
FD	Fiber Diameter
FERD	Faculty of Environmental Science and Resource Development, or FESNARE
FESNARE	Faculty of Environmental Science and Resource Development, or FERD
FEWS NET	Famine Early Warning System Network
FHI	Food for the Hungry International
FMD	Food and Mouth Disease
FVI	First Voice International
GANLAB	Grazingland Animal Nutrition Laboratory, Texas A&M
GHA	Greater Horn of Africa
GHS	Ghana Health Services
GIS	Geographic Information System
GL-CRSP	Global Livestock Collaborative Research Support Program
GO	Government Organization
GOBI	GOBI-Forage, GL-CRSP Project
GOK	Government of Kenya
GPS	Global Positioning Systems
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit (German Agency for Technical Cooperation)
ha	Hectare
HAART	Highly Active Retroviral Treatment
HALI	Health for Animals and Livelihood Improvement, GL-CRSP Project

HNP	Increasing Animal Source Foods in Diets of HIV-infected Kenyan women and their children, GL-CRSP Project
HPAI	Highly Pathogenic Avian Influenza
HQ	Headquarters
ICAB	Institute for Countermeasures Against Agricultural Bioterrorism
ICPAC	IGAD Climate Prediction and Applications Centre
ICT	Information and Communication Technology
IGA	Income Generating Activities
IGAD	International Governmental Authority on Development
IGC	Intergovernmental Conference (EU)
ILRI	International Livestock Research Institute
INCAP	Instituto de Nutricion de Centro America y Panama
IPAL	Integrated Project for Arid Lands
ISU	Iowa State University
IU	Indiana University
IWMI	International Water Management Institute
IWTO	International Wool Textile Organization
JSS	Junior Secondary School
KACE	Kenya Agriculture Commodity Exchange
KARI	Kenya Agricultural Research Institute
KDA	Kenya Rural Enterprise Program Development Agency
KLMC	Kenya Livestock Marketing Council
KLTA	Kenya Livestock Traders Association
kg	Kilogram
KMD	Keyna Meteorological Association
KPPG	Kenya Pastoral Parliamentary Group
KSBA	Kyrgyz Sheep Breeders' Association
Ksh	Kenya Shilling
LEWS	Livestock Early Warning System
LiTEK	Livestock Marketing in Kenya and Ethiopia (a GL-CRSP Project)
LINKS	Livestock Information Network and Knowledge System
LMIS	Livestock Market Information System
LMPWNA	Lunda-Mkwandi Pilot Wildlife Management Area

LULCC	Land Use and Land Cover Change
MASHAV	Hebrew acronym for Center for International Cooperation
MBOMIPA	Lunda-Mkwambi Wildlife Management Area, Tanzania
MDP	Marsabit Development Program
ME	Management Entity
MET	Meteorology
MoARD	Ministry of Agriculture and Rural Development
MOFA	Ministry of Food and Agriculture, Ghana
MoLFD	Ministry of Livestock and Fisheries Development
MOU	Memorandum of Understanding (also MoU)
MU	Makerere University
MU	Moi University
MUAC	Mid-Upper Arm Circumference
NACC	National AIDS Control Council, Kenya
NAFTA	North American Free Trade Agreement
NALRC	National Arid Lands Research Center
NARC	Natural Agricultural Research Council
NARO	National Agricultural Research Organization
NASA	National Aeronautics and Space Administration
NASCOP	National AIDS and STI Control Program, Kenya
NDVI	Normalized Difference Vegetation Indices
NGO	Non-Government Organization
NIRS	Near Infrared Reflectance Spectroscopy
NH ₄ -N	Ammonium Nitrogen
NHANES	National Health and Nutrition Education Strategy
NICHHD	National Institute of Child Health and Human Development
NNP	National Nutrition Programme
NOAA RFE	National Oceanographic and Atmospheric Administration Rainfall Estimate
NRCS	National Resource Conservation Service (United States)
NPP	Net Primary Production
NREL	Natural Resource Ecology Laboratory
NSF	National Science Foundation

NUTBAL	Nutritional Balance Analyzer
OADB	Oromia Agricultural Development Bureau
OARI	Oromia Agricultural Research Institute
OCPB	Oromia Cooperative Promotion Bureau
ODWA	Ogaden Welfare Deveopment Association
OFDA	Office of Foreign Disaster Assistance (USAID)
OFDA	Optical Fiber Diameter Analyzer
OIE	World Organization for Animal Health
OPDC	Oromia Pastoral Development Commision
PAHO	Pan American Health Organization
PAR	Participatory Action Research
PARIMA	Pastoral Risk Management Project (GL-CRSP)
PEPFAR	President's Emergency Plan for AIDS Relief
PHYGROW	Plant Growth/Hydrology/Yield Simulation Models
PI	Principal Investigator
PLI-EW	Pastoral Livelihoods Initiative - Early Warning
PLMMO	Pastoral Livelihoods Movement Model
PLWHA	Persons Living With HIV/AIDS
POU	Point Of Use
PRA	Participatory Rural Appraisal
PRA	Participatory Rapid Assessment
RANET	Radio and Internet
RAP	Research Activity Plan
RATIN	Regional Agricultural Trade Intelligence Network
RCMRD	Regional Center for Mapping of Resources for Development
RECONCILE	Resource Conflict Institute
REDSO	Regional Economic-Development Services Office for East and Southern Africa (USAID)
RFQ	Request for Qualifications
RIAH	Research Institute of Animal Husbandry, Agriculture University of Mongolia
RIING	Research to Improve Infant Nutrition and Growth
RNP	Ruaha National Park
RUFORUM	Regional Universities Forum for Capacity Building in Africa

RUSLE	Revised Universal Soil Loss Equation
SANREM	Sustainable Agriculture and Natrual Resource Management CRSP
SCF - UK	Save the Children Fund (United Kingdom)
SCF - USA	Save the Children Fund (United States)
SHILDA	South Highlands Livestock Development Association, Tanzania
S/K	Somalia/Kenya
SMS	Short Message Service
SNV	Netherlands Development Organization
SODIS	Solar Disinfection
SPS-LMM	Sanitary and Phytosanitary Livestock Meat Marketing Project, Texas A&M
STI	Southern Tier Initiative
SUA	Sokoine University of Agriculture
SUMAWA	Sustainable Management of Watersheds: the River Njoro, Kenya (GL-CRSP)
SWAT	Soil and Water Assessment Tool
TARDA	Tana and Athi Rivers Development Authority
TAMU	Texas A&M University
TANAPA	Tanzania National Parks
TAWIRI	Tanzania Wildlife Research Institute
TBA	Traditional Birth Attendants
TN	Total Nitrogen
TP	Total Phosphorous
TE	Terra Nueva
TZ	Tanzania
UCD	University California, Davis
UCLA	Univeristy of California, Los Angeles
UG	University of Ghana
UGR	Usungu Game Reserve
UK	United Kingdom
UNAIDS	Joint United Nations Programme on HIV/AIDS
UNEP	United Nations Environmental Programme
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UNDP	United Nations Development Programme

UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
USD	United States Dollar
USDA ARS	United States Department of Agriculture Agricultural Research Service
USGS	United States Geological Survey
USFS	United States Forest Service
USU	Utah State University
UT	Utah
UV	Universit of Vermont
UW	University of Wisconsin
VCI	Vegetation Condition Index
VIP	Village Infrastructure Project
VOCA	Volunteers in Overseas Cooperative Action
VSF	Veterinaires Sans Frontiers - Suisse
WB	World Bank
WCS	Wildlife Conservation Society
WEAP	Water Evaluation And Planning System
WFP	World Food Program
WHO	World Health Organization
WID	Women in Development
WMO	World Meteorological Organization
WOOL	Developing Institutions and Capacity for Sheep and Fiber Marketing in Central Asia, GL-CRSP Project
WRMA	Water Resource Management Authority, Kenya
WTO	World Trade Organization