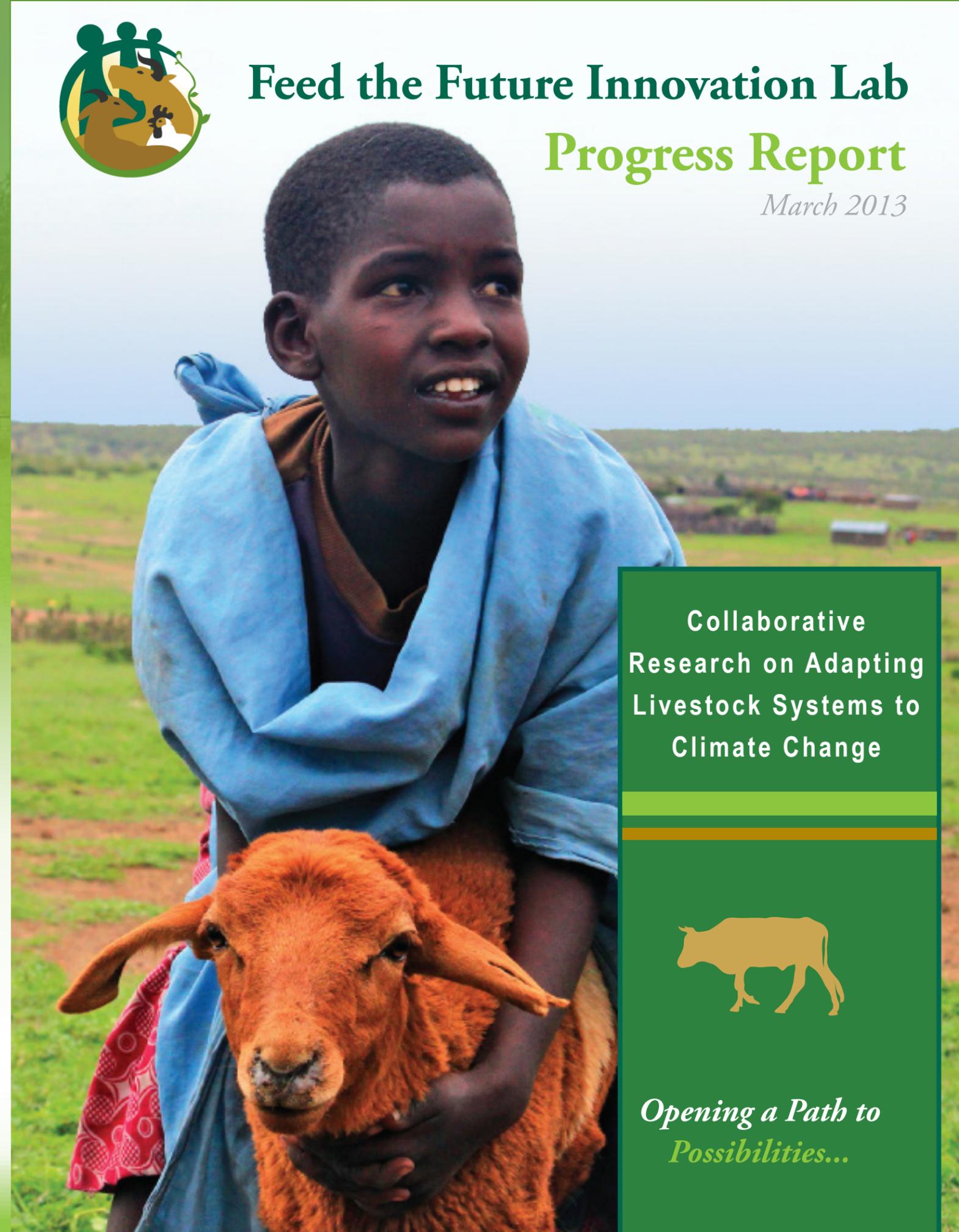




Feed the Future Innovation Lab Progress Report

March 2013



Collaborative
Research on Adapting
Livestock Systems to
Climate Change



*Opening a Path to
Possibilities...*

This publication was made possible through support provided by the Bureau for Economic Growth, Agriculture, and Trade, U.S. Agency for International Development, under the terms of Grant No. EEM-A-00-10-00001. The opinions expressed herein are those of the authors and do not necessarily reflect the views of the U.S. Agency for International Development or the U.S. government.



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A Message from the Management Team

Dear Friends,

We are now almost three years into our collaborative research program and we are confident our activities in South Asia and Africa are making steady progress toward generating information and developing technologies that can help policymakers and livestock holders increase the resiliency of livestock systems in the face of changing climatic conditions.

In the next two years, we look forward to extending the impact of our current research and initiating exciting new research directions that increase understanding at the intersection of animal, human, and environmental health. We will be looking for new technologies that can more precisely measure connections between climatic conditions, nutrition, and food safety. We will also be exploring the use of innovative tools and practices for addressing gender and nutrition issues in small-scale production, especially at the household level.

Dick Bowen, Director
Shana Gillette, Deputy Director

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Climate variability is an important determinant of animal, human, and environmental health. Changes in precipitation and temperature can affect the quality and quantity of forage available to animals at times when it is needed most. In addition to facing challenges from a changing climate, populations in South Asia and Sub-Saharan Africa are also undergoing rapid social transformation, facing reductions in communal resources and the reorganization of social obligations, networks, and governance.

Our research focuses on eco-regions and/or river systems that extend across national boundaries and meet the following criteria: 1. climate change is significantly increasing the vulnerability of livestock systems in the area, 2. opportunities for collaborative research activities exist with other institutions and organizations, 3. opportunities exist for trans-boundary research that has applicability at the community level.

We support research that helps individuals and communities make choices and take actions that lead to sustainable livelihoods under changing climatic conditions. Our research focus is South Asia and Sub-Saharan Africa where livelihood and health are tied to interactions with the land and livestock. We fund long-term US university research and we support promising mini-grant research by early-career researchers who are based at universities, institutes and relevant NGOs. Our graduate fellowships are funding students from *Feed the Future* focus countries to pursue graduate degrees and become the next generation of researchers. We also support workshops and symposia that provide on-the-ground training for livestock holders and agricultural professionals.

Climate Extremes and Longterm Change

In Nepal, we support two longterm research projects that are seeking to better understand how climatic conditions are changing and impacting agricultural systems in the region. University researchers on the climate project in Far-Western Nepal are examining monsoon patterns and how shifts in precipitation may affect livestock production. Our second climate project is focused on the Gandaki

River Basin. The objective is to downscale regional climate data and provide guidance on managing risk in areas in Nepal that have a high likelihood of extreme climate-related events in the future.

Animal Health: Disease Distribution & Resiliency

Health for Animals and Livelihood Improvement in Tanzania, HALI-2, assesses the effects of zoonotic disease (diseases passed between animals and people) and water management on health and livelihoods in Tanzania. We also fund several graduate students and early-career researchers who are examining the links between changing climatic conditions and diseases that affect animal health and production. At the household level, we are creating curriculum in poultry education so school children can learn how animal health and nutrition are linked.

Ecosystem Health: Resiliency of Socio-Ecological Systems

Our research helps increase SES resiliency by gathering data on mobility patterns and adaptation preferences. In W. Africa, we have developed a pastoral ecosystem model to predict the effect of climate change and land-use patterns on key resources such as water, fodder, and movement. Another W. Africa project is mapping movement corridors and identifying potential areas of conflict. In Nepal, we are identifying the impact of ecosystem changes on livestock systems in the high hills of Nepal of the Gandaki River Basin. In addition to these longterm university projects, we are also funding several early-career researchers in Nepal who are working closely with U.S. university researchers on complementary research themes.

Pro-Poor Value Chains: Market Access and Reliability

In the Borana region of Ethiopia we are looking at how herders access market chains in remote areas, how weather-related risks affect market access, and which producer groups (including women) benefit from different markets. We are also identifying “best-bet” land and livestock interventions in the Borana that will move pastoral systems toward sustainability and will encourage the adoption of promising innovations in livestock diversification, rangeland productivity, and improved forage quality.



The goal of the Innovation Lab is to increase resilience and augment the income of livestock producers in regions where agricultural systems are changing, available resources are shrinking, and climate is having an impact.

The Innovation Lab focuses on the following research priorities to achieve its goals:

- Improve the health and productivity of livestock while benefiting the health and welfare of farm families and conserving natural resources.
- Integrate market research with the needs of small-scale farmers.
- Collect and analyze data from farms, partners, and governments that informs evidence-based solutions.
- Increase research capacity through training and educational support.
- Extend the reach of funded research by leveraging resources and partnering with other organizations with similar research and development goals.

The Innovation Lab focuses on the following key principles to achieve its goals:

- We are interested in improving the health and productivity of livestock of the rural poor. We work with small-scale farmers to support their efforts to nourish their families and increase village resiliency.
- We support research informed by the local realities of small-scale farmers. We are interested in evidence-based solutions that are relevant and affordable.
- We are interested in increasing productivity that enhances animal, human, and environmental health. We focus on innovative approaches that increase productivity, enhance health, and conserve resources.
- Women are central to the research that we fund. We recognize that women are fundamental to the success of farm-based initiatives and expect research solutions to address gender gaps and inequalities.

List of Acronyms

AAAS

American Association for the Advancement of Science

GHG

Greenhouse Gas

GIS

Geographic Information Systems

GRB

Gandaki River Basin

HALI

Health for Animals and Livelihood Improvement

LEO

Livestock Extension Officer

NGO

Non-Governmental Organization

USAID

U.S. Agency for International Development

Universities

ASU

Arizona State University

CSU

Colorado State University

CUNY

City University of New York

MSU

Michigan State University

SDSU

South Dakota State University

UC Davis

University of California-Davis

UF

University of Florida

USU

Utah State University

Research Rationale

Progress Report



Livestock systems are an integral part of many rural economies. In many developing countries, livestock production is more than half the GDP. Part of that agricultural growth is the result of an increasing demand for livestock products. At the same time that demand is increasing, changing climatic conditions are having an impact on the health of socio-ecological systems on which livestock holders depend. Climatic conditions are expected to affect livestock systems by limiting the quality and availability of feed and forage, expanding disease distribution, decreasing productivity, and thereby having a deleterious effect on animal health.

Studies suggest that elevated CO2 and higher temperatures are likely to decrease the nutritive quality of forage and shift vegetation from forage to non-forage species, especially in already marginal rangelands. Increasing temperatures are also likely to have a negative impact on production as livestock reduce physical movement, limit grazing, and lower metabolic rates to dissipate and conserve heat. In livestock systems already compromised by these environmental stressors, the spread of disease can have a devastating impact. Climatic conditions such as the unpredictability and severity of rainfall patterns and temperature extremes are speeding transmission and transport of water-borne pathogens and zoonotic disease in some of the most populated parts of the world that already have severely weakened socio-ecological systems. For livestock embedded in these already weakened systems, it is much more difficult to rebound from extreme weather events.

Livestock systems in South Asia and Africa are an integral component of socio-ecological systems that are currently experiencing a range of climatic stressors and shocks. Higher temperatures, longer droughts, and shifts in the intensity and frequency of precipitation patterns are just a few of the impacts that are heightening livelihood uncertainty for livestock holders. For most livestock holders with limited access to resources, adaptation requires short-term coping strategies that may not be the best options for mitigating harm or benefiting from opportunities. Pastoralists are facing increasingly limited options for adapting to weather extremes. During long droughts they can move their livestock, but encounters with conflict and disease are likely as livestock crowd onto scarce ecological patches for limited water and

forage. Livestock holders can change the type of livestock they manage, but such shifts to small ruminants, for example, could exclude pastoralists from lucrative markets that focus on larger animals such as cattle and camels. Another option is to shift from reliance on rangelands to zero-grazing and use of nutrient-rich feed. However, while this arrangement can benefit a household by providing animal-based protein in the household diet, it is challenging for resource-poor households who rarely have food left over for livestock feed and who face increased disease risk from close contact with livestock. Fattening livestock for market is another option, but forage is increasingly scarce in many areas as farmers convert pasture to cropland. Diversification into other money-making activities or exiting livestock holding completely are the final options open to pastoralists.

Co-evolution of livestock holders within an agro-ecosystem requires that they be responsive to a range of political, social, cultural, physical, and financial forces impacted by climate change. As the impacts of climate change accumulate, small adjustments (coping strategies) in a system may no longer make it possible to persist in the same practices. Instead, systems-level adjustments may be required such as livelihood diversification or changing livestock type. However, for a small-scale livestock holder, the transaction costs of large-scale change are high, depleting emotional, physical, financial, and social resources. Therefore, livestock holders with limited resources are likely to persist in incremental changes that may be a form of maladaptation, diminishing their small amount of capital and making substitutions that affect their health.

We identify innovations that will help livestock holders co-evolve and adapt toward sustainable systems under challenging climatic and socio-economic conditions. We are also contributing knowledge on how sustainable agro-ecosystems benefit public health by establishing clear and quantifiable relationships between agro-ecosystem functions and the cost-benefit to public health, especially in the areas of food safety, nutrition, and health prevention. Our research will contribute to an evidence base on the health benefits of sustainable livestock systems.

Our Evolution Over Time

Progress Report



From CRSP to Innovation Lab

Small Ruminant CRSP

In 1978, the USAID awarded UC Davis one of nine Collaborative Research Support programs developed under Title XII of the International Development and Food Assistance Act of 1975. The CRSP model took advantage of the strengths inherent in U.S. land-grant universities.



Global Livestock CRSP

In the mid-1990s, the small ruminant CRSP began a program restructuring that resulted in the formation of the Global Livestock CRSP at UC Davis. The goal of the GL-CRSP was to: integrate livestock productions with the rational use of natural resources, decrease poverty, increase food security, enhance nutritional status, strengthen institutional capacity, develop communication systems, and support decisionmaking.



Global Livestock CRSP

Adapting Livestock Systems to Climate Change CRSP

Colorado State University received a five-year, \$15 million Leader-with-Associate Award from the U.S. Agency for International Development (USAID) in 2010 to manage the Collaborative Research Support Program, Adapting Livestock Systems to Climate Change (Livestock-Climate Change CRSP).

The Livestock-Climate Change CRSP built on the successes of the previous GL-CRSP while addressing new and emerging challenges related to global climate change and the new *Feed the Future* initiative which focused research efforts in Nepal, Tanzania, Senegal, Mali, Ethiopia, and Kenya.



Feed the Future Food Security Innovation Laboratory

In 2013, USAID initiated a name change from CRSPs to Innovation Labs. The LCC CRSP is now a *Feed the Future* Food Security Innovation Laboratory: Collaborative Research on Adapting Livestock Systems to Climate Change. We intend to keep building on our previous success as a CRSP while exploring new forms of collaboration related to livestock systems and climate change. We intend to deepen our understanding of climate change impacts while broadening the scope of our research to include more stakeholders with interest in nutrition and food safety at the household level. Our goals will remain: reducing poverty, increasing food security, and enhancing health.



Research Themes

Progress Report



Focus Countries

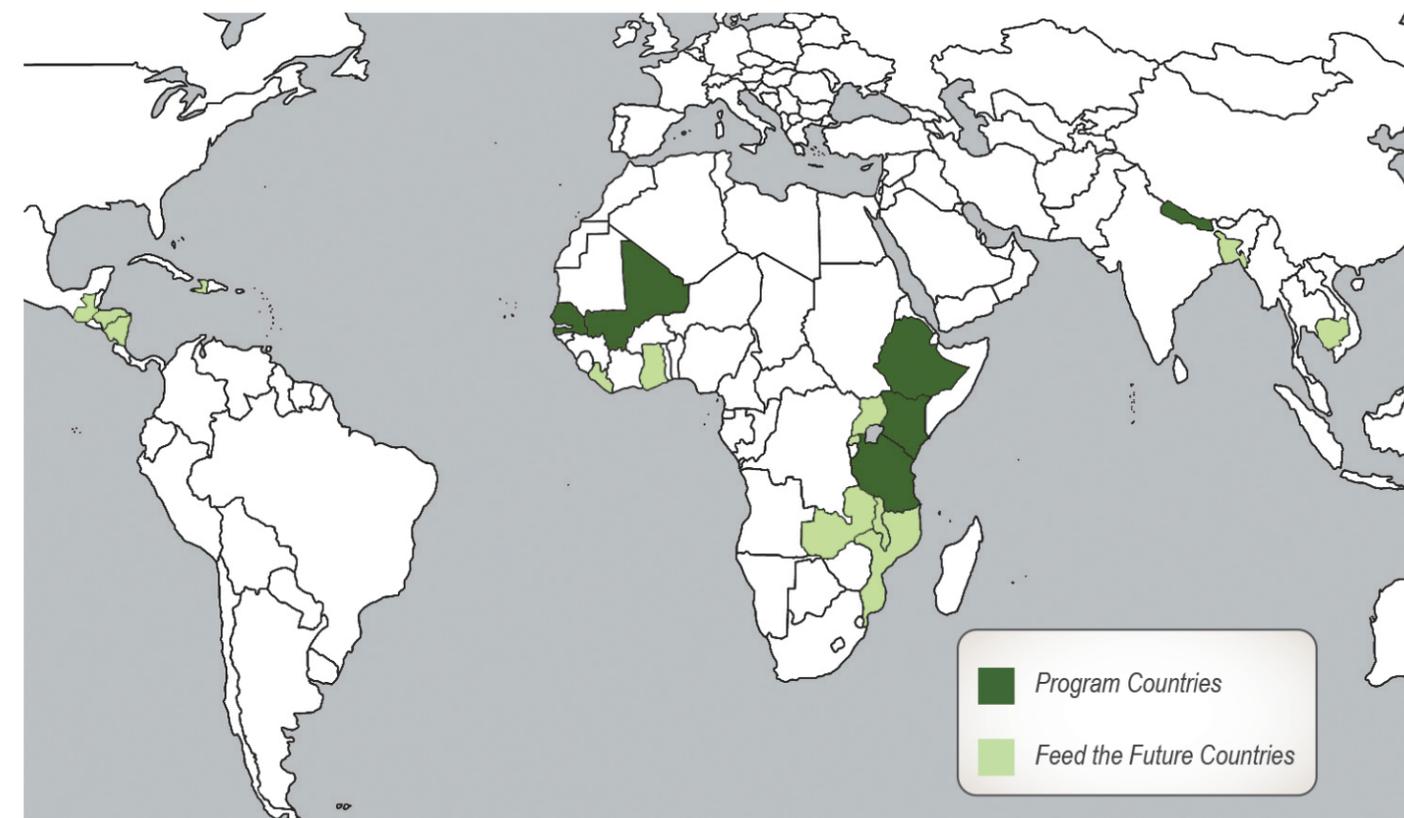
Progress Report



We value and support gender-informed* research to increase access to safe and nutrient-dense foods:



Colorado State University's *Feed the Future* Food Security Innovation Lab works in six of the 20 *Feed the Future* focus countries. *Feed the Future* is a USAID initiative that prioritizes USAID efforts to reduce global hunger and poverty. Our Innovation Lab coordinates with USAID Bi-lateral Missions to conduct research to answer key questions on health and livestock systems in the face of climate change.



*We recognize that women are fundamental to the success of farm-based initiatives and expect research solutions to address gender gaps and inequalities.

CSU receives Leader with Associates Award from USAID to manage "Adapting Livestock Systems to Climate Change: A Collaborative Research Support Program"

April 2010

USAID Bi-lateral Mission to Mali issues \$5.25 million poultry and pastoralism Associate Award

December 2010

Nepal Seed Grant Awards announced, \$240,000 awarded to three U.S. universities and their international partners

May 2011

Longterm Research Awards for E. Africa announced, \$1.3 million awarded to Emory University and UC Davis

October 2011

Longterm Research Awards for W. Africa announced, \$1.3 million awarded to South Dakota State and Syracuse University

November 2011

Longterm Research Awards for Nepal announced, \$2 million awarded to Arizona State, CUNY, and Michigan State

June 2012

Gap-filling research award of more than \$450,000 announced for E. Africa

November 2012

October 2010
E. Africa and W. Africa Seed Grant Awards announced, \$720,000 awarded to nine universities and their international partners

January 2011
International Fellowship Awards for Graduate Research announced, six students, three from E. Africa, receive awards

May 2011
Dr. Richard Bowen, CSU professor in CVMBS, assumes Directorship.

November 2011
International Fellowship Awards for Graduate Research announced, three fellows from Nepal and three from Mali receive awards

February 2012
Dr. Shana Gillette, CSU assistant professor in CVMBS, assumes Deputy Directorship.

October 2012
TIRI (targeted investment for research impact) Scholars announced for Nepal and E. Africa

December 2012
USAID renames "Collaborative Research Support Programs", "Feed the Future Food Security Innovation Labs"

Alignment with Feed the Future

Progress Report



The *Feed the Future Innovation Lab* at Colorado State University measures its progress, in part, by a series of indicators that are connected to *Feed the Future* outcomes and advances in research, technology, and knowledge. Two new *Feed the Future* indicators came online in 2012 to measure the impact of climate change knowledge on policy. These indicators align with our goal to fund collaborative research that informs policy at national, regional, and international levels. In addition, we inform livestock-related policies and administrative processes at country and regional levels. Agricultural productivity depends on increases in the application of technology and the transfer of knowledge. We have been active in assisting groups to increase productivity through short-term training and field applications. We are also forming the next cadre of specialists and researchers at the intersection of animal and human health to improve animal health while increasing access to nutrition and improving livelihoods.



TIRI Scholars for South Asia meet in Kathmandu in October, 2012 to refine their pre-proposals into full proposals. Joyce Turk from USAID served as one of the mentors at the research retreat.

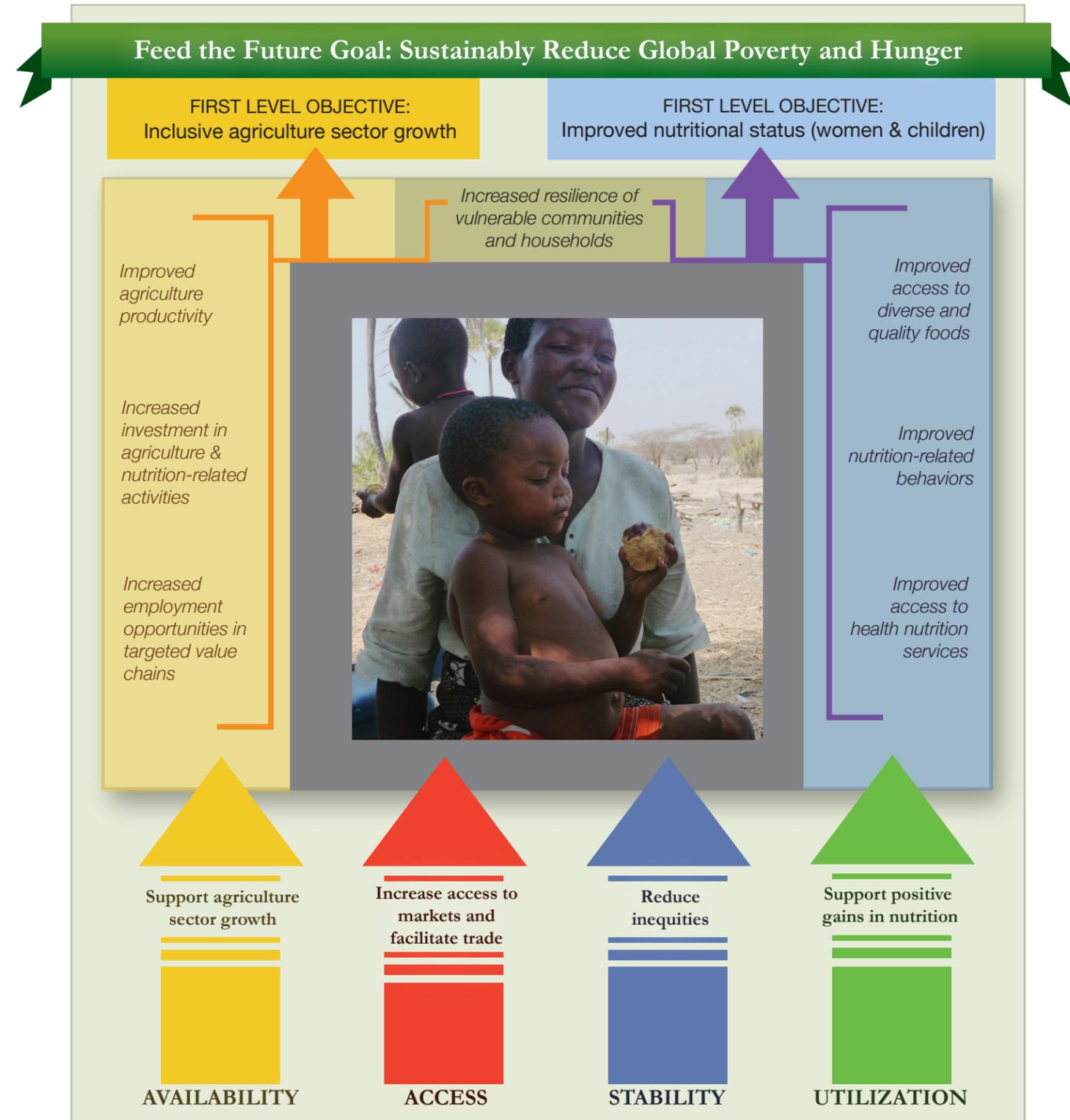


Graduate Student Fellow in Ethiopia.

Food Security Innovation Lab Aligned with Feed the Future Outcomes	
IR1: Improved Agricultural Productivity	Use of Climate Information and Assessment in Decisionmaking
	Policies and Regulations in Stages of Development
	Development and Application of New Technologies
	Training and Assistance for Agricultural Stakeholders
IR 2: Expanding Markets and Trade	Number of farmers and others receiving business development services.
IR 3: Increased Investment in Agriculture and Nutrition-related Activities	Number of public-private partnerships receiving assistance. Number of organizations operating more profitably because of USG assistance.
IR 5: Increased Resilience of Vulnerable Communities and Households	Number of households reached through nutrition programs. Number of individuals trained in child health and nutrition.

Alignment with Feed the Future

Progress Report





Number of individuals receiving short-term ag sector productivity or food security training...

1,110
Males

438

Females

Short-term Training Addresses Diverse Needs

The short-term training for the Innovation Lab covers a broad spectrum of activities. For example, as part of ongoing research activities, researchers share information across stakeholder groups on perceptions, attitudes, and behavior related to adapting livestock systems to climate change. These exchanges can occur through focus groups and interviews with farmers, small business owners, government staff, and other stakeholders. Information exchange also occurs in more formal settings. For example, farmers gather at field sites or demonstration farms to provide input on new technologies or production practices.



Short-term training can also occur in more traditional settings such as workshop, seminars, or conferences. At these more formal meetings, stakeholders may present or participate in discussions of new research, technologies, strategies, and practices related to adapting livestock systems to climate change.

At the Innovation Lab, we believe in training across the lifespan with sensitivity to providing information for different stages in an individual's professional and livelihood development. For example, the CSU Lab's poultry project spans three countries and works with schoolteachers in each of those countries to prepare poultry-keeping curriculum for children in elementary school.

In E. Africa, veterinarians receive short-term training in zoonotic disease to be more prepared to identify shifts in disease spread across elevation and temperature gradients. In West Africa, we have collaborated with university faculty and students on training focused on improving GIS competencies and we are working on providing support for a regional GIS training effort that will help identify and track changes in the distribution and availability of resources for farmers and livestock holders across the Sahel.

Short-term Training can have Long-term Benefits

Our targeted approach to training ensures that short-term training can have long-term benefits. Professional training tailored to the needs of early-career researchers helps build a solid formation for a cadre of researchers across institutes and universities who will contribute to strengthening research infrastructure in the future. Training for farmers that is based on current interests and needs and responsive to feedback is more likely to be integrated more readily into farm practices.

Types of Short-term Training

Livelihood

Relevance: knowledge contributes to increased production and improvements in health

- Community or household assistance
- Family-focused
- Sensitive to community needs

Professional

Relevance: knowledge contributes to increased career opportunities and improved performance

- Professional development
- Equity-based professional practices
- Timely and responsive to regional needs

Institutional

Relevance: knowledge builds long-term commitment to research development and collaboration

- Infrastructure development
- Equity-based institutional processes
- Forward thinking, anticipating future needs





Number of individuals receiving long-term ag sector productivity or food security training...

32 Males

11 Females



Graduate Student Fellow in Nepal, Tara Nath Gaire, collects samples for his fieldwork.

TIRI, Targeted Investment for Research Impact

Our Lab identifies early-career researchers who are interested in tackling livestock production problems with innovative approaches and from fresh perspectives. This small-grant program is open to early-career researchers (five or fewer years into their research careers) from any discipline, from student to professor, and from any organization that is engaged in applied research on livestock production—colleges and universities, government research centers or laboratories, or non-profit organizations.

Early-career researchers are funded to build capacity in making livestock production systems more resilient to increasing climate variability and severity. At the end of one year, TIRI scholars are expected to demonstrate concrete outcomes and real potential for future impact. TIRI scholars are at all levels of education from early-career faculty to senior undergraduates in professional programs who are gaining valuable research experience. TIRI scholars are based in research institutes, universities and non-profit organizations that are currently our partners in agricultural, ecosystem, and climate research on livestock systems and livelihoods in rural communities.

The TIRI program provides research support to TIRI Scholars throughout the process, from application to final results. In Nepal, TIRI Scholars met at a research retreat in October, 2012 to refine their accepted pre-proposals for resubmission. At the research retreat, a AAAS scholar from USAID served as a mentor along with U.S. university faculty and USAID staff. Following participation in the research retreat, TIRI Scholars received input on their final proposals and had the opportunity to participate in a workshop on research methods.

International Graduate Student Fellows

Well-trained, innovative scientists and leaders are essential to building a sustainable, prosperous future. The CSU Lab enhances research capacity in each target region, in part, by training graduate students. The Graduate Student Fellowship Program (GSFP) provides partial support for graduate students in order to improve the overall quality of their research and prepare them for interdisciplinary careers.

Fellows are expected to become specialists who can contribute to research regarding the adaptation of livestock systems to climate change in the countries of focus. Selected fellows must propose to conduct research in one or more of the focus countries. The majority of Graduate Student Fellows are funded to complete PhD programs in their country. A few are funded for studies in the US.

Graduate Fellows not only work with regional and international specialists in their fields of study, they also have the opportunity to attend short courses of study, seminars, conferences, and technical training. Fellows share their experiences and extend their research network through new partnerships.



Long-term Training Research Themes

Disease Distribution and Resiliency to Disease

Problem: increases in livestock-related disease epidemics. For example:

- Infectious abortion diseases of livestock
- Diseases transmitted between livestock and humans
- Vector-borne diseases

Ecosystem Health: Resiliency of Socio-ecological Systems

Problem: changes in forage and fodder that affect animal health and nutrition. For example:

- Emergence of invasive/toxic plants in rangeland

Climate Extremes and Long-term Change

Problem: direct effects of climate variability/severity on livestock systems. For example:

- Environmental stresses that decrease production



Leveraging Technology for Better Management

In our technology development, we are integrating the knowledge of climate scientists, animal health workers, nutrition educators, and production specialist to better understand the impact climate change is having on production and health. We achieve this through a variety of methods that employ scientific techniques from climate science, social science, animal science, and the natural sciences. We focus on technological applications that have relevance to smallholder management of livestock in a variety of settings, from rangeland to households and markets.

Mobile phone technology can provide real-time information for sellers and buyers. Researchers in East Africa are testing the use of mobile phones in providing real-time market and climate information to small-scale livestock holders for market negotiations.



Taking Blood Samples in Kenya. Photo Credit: Gitahi. We are integrating health and climate data to understand the impact of changing climatic conditions on the socio-ecological components of livestock systems.

Number of new technologies in development...

21 Technologies

Remote Sensing and computer modeling are two technologies that we are leveraging to better understand how changing climatic conditions are impacting animal and human health. In West Africa, we are applying remote sensing herd GPS installations to more precisely monitor herd movements during rainy and dry seasons. Integration of transhumance corridor information with geospatial data helps identify areas of potential conflict relating to water and grazing access.

In East Africa, we are using computer modeling to highlight areas where the supply of freshwater may be insufficient to meet demand. By integrating disease data into the model, we are able to gauge zoonotic disease incidence in these areas of high-demand. In addition to computing technologies, we are evaluating “best practices” in resilience for livestock holders.

Analyzing Policies for Improved Management

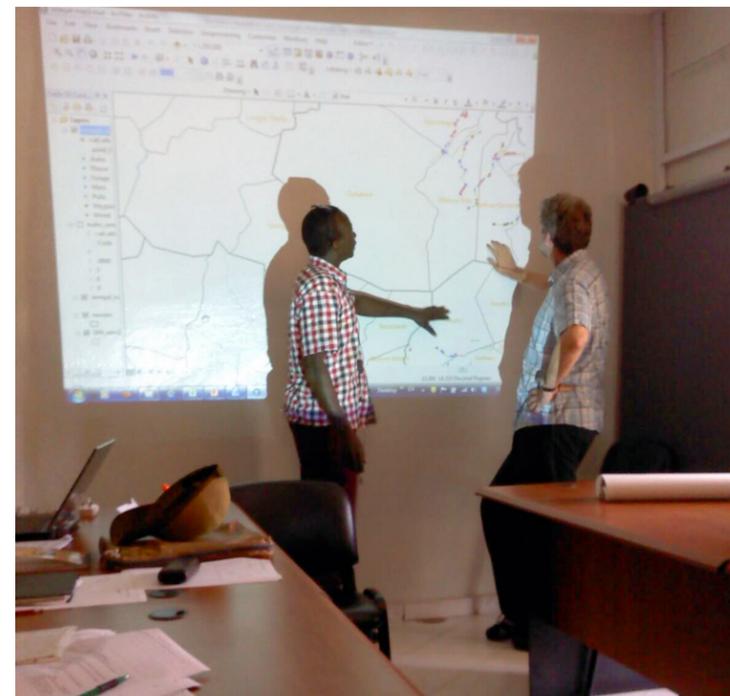
Across our research projects, we are involved in the analysis of national and local policies on land-use and other issues that directly impact livestock management. It is important to understand the current and past policy context at the local, national, and regional levels, to gain a better understanding of how additional data and knowledge may inform future decisionmaking. In West Africa, we have analyzed land-use policies in our study of transhumant corridors. In E. Africa, we are studying export and import policies related to livestock markets to better understand how these policies are affecting small-scale livestock holders.

Assessing Climate in an Agricultural Context

In South Asia, we are conducting one climate assessment in Far-western Nepal and will soon undertake another climate assessment in the Gandaki River Basin. Our first climate

Number of policies/regulations/administrative procedures in stages of development and number of climate vulnerability assessments conducted as a result of USG assistance...

36 Policies 1 Assessment



Discussion of transhumance corridor mapping in Tambacounda. Photo Credit: Mamoudou Keita

assessment, which identified a shift in the monsoon season, has been critical to understanding the impact that changing climatic conditions are likely to have not only on livestock systems, but on all agricultural systems in the region. The climate assessment, led by Utah State University, indicated:

- Decline in winter rain
- Severe decadal-scale drought
- Rapid decrease in groundwater
- Noticeable decline in mountain glaciers

The climate assessment is currently being used as a reference for policy decisions regarding adapting agriculture to climate change in Nepal. Additional funding is extending the scope of the assessment to identify impacts on household production and nutrition. The City University of New York will be taking the lead on an assessment in another region in Nepal, the Gandaki River Basin, that was specifically requested by the USAID Mission.



GENERATE INTEGRATE ACTIVATE



Our network of research partners includes national agricultural institutes such as the Nepal Agricultural Research Council.

Along our impact pathway, we generate interesting questions that help identify knowledge gaps and needs at local and regional levels. We integrate thinking across disciplines to design research approaches that are interdisciplinary and transnational in nature. Through degree and non-degree training, we activate individuals, households, communities, and governments to assess current practices and knowledge that lead toward the design and implementation of innovative solutions.

Our program's foundation is a set of reinforcing and integrated research activities that address the impacts of changing climatic conditions on livestock holders in S. Asia and Africa: increasing temperatures; increasing frequency and intensity of drought and heavy rains; lack of reliable water resources; and lack of market options to strengthen resilience in the face of socio-economic shocks.

This progress report marks the mid-point of our program evolution which started with the launch of *Feed the Future*. Since our inception, we have conducted evaluations to identify promising research trajectories that warrant funding. After reviewing results from pilot studies in South Asia, East Africa, and West Africa following the first year of our program, we identified projects that had the highest potential for impact in both the research and development arena and funded three-year projects in the second year of our program.

The overall impact of our research portfolio will be measured by how well we align our initial program objectives with the ongoing evolution of the USAID *Feed the Future* initiative. In order to ensure alignment with the initiative and our research and development goals, we have created an alignment plan to foster joint ownership in our research among our focus country partners, US universities, and USAID. The alignment plan, created at the mid-point of our program, is serving as a guide to inform the impact assessment of our individual research projects and overall program. Starting in 2013, we will undertake a series of activities to build capacity in evaluating our research projects for early results and longterm development impact. We are also instituting a transparent, online process for charting our progress over time.



Our partners are a critical component of our success. Helen Keller International in Nepal is one of the many organizations that we work with to build resilience at the household level that improves human nutrition and animal health.





Nepal



Key Accomplishments

- Completed climate assessment in Far-Western Nepal, initiated an assessment in the Gandaki River Basin
- Launched mini-grant program for early-career researchers (TIRI)
- Produced journal articles with Nepali co-authors, leveraged funding resources

South Asia is undergoing changing climatic conditions that are increasing temperatures in the lowlands, shifting the onset of the monsoon season, affecting the quality and quantity of forage production in the mid-hills, and increasing the speed of

glacier melt in higher elevations. These changing climatic conditions are expected to have an impact not only on the agro-ecosystems in Nepal, but on the agricultural systems downstream in India. The importance of Nepal as a headwater source for agricultural water makes climate assessments essential to understanding evolving agricultural needs in the next ten years.

For small-scale livestock holders, these changes are likely to impact decisions on the type of livestock they keep, when to buy and sell, and what forage and feed to use in the dry and rainy seasons. Our lab is using new statistical techniques to analyze climate data and produce results that will aid policymakers and livestock holders in devising resilient adaptive strategies. We are also funding several early-career researchers to examine the impact of these changing climatic conditions on disease spread.

Research Impact: Climate Assessment

Utah State University (USU) and the City University of New York (CUNY)-City College are leading the Lab's climate assessments for Nepal. USU has already completed a climate assessment that has helped inform decisions at the Ministry level regarding climate change impacts on agricultural production in Far-Western Nepal.

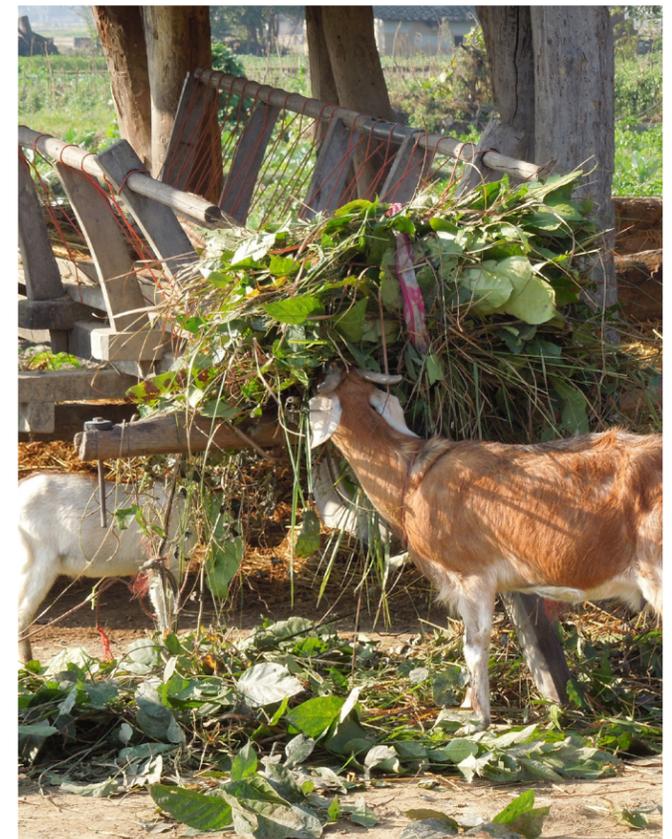
Research by CUNY is currently underway to complement the climate assessment in Far-Western Nepal with a climate assessment in the Gandaki River Basin (GRB). The Bi-lateral Mission in Nepal identified the climate assessment as high priority because it will not only provide information on a river basin that supports agriculture in the Terai region of Nepal, but also supplies water to the Middle Gangetic Plains.

Results from the Far-Western climate assessment indicated the likelihood of impending drought Nepal (Gillies and Wang, 2012). By analyzing precipitation data, paleo (tree-ring) data, and data from the NASA Grace twin satellites, Gillies and Wang observed a robust decline in winter rain since 1995 over western Nepal, a rapid decrease in ground water in recent years, and found the most recent drought to be unprecedented in severity. These findings have helped shape the direction of a more in-depth assessment which will be completed in 2015. Early results from that research have recently been reported (Gillies et al., 2013).

Initial results from a socio-ecological assessment in the same region has identified current adaptation strategies for herders and has helped build a framework for action by policymakers in Nepal (Chhetri, 2011). Arizona State University in collaboration with partners in Nepal is leading the research which will be completed in 2015. Michigan State University will be adding to this evidence base by examining climate impacts on water buffalo production.



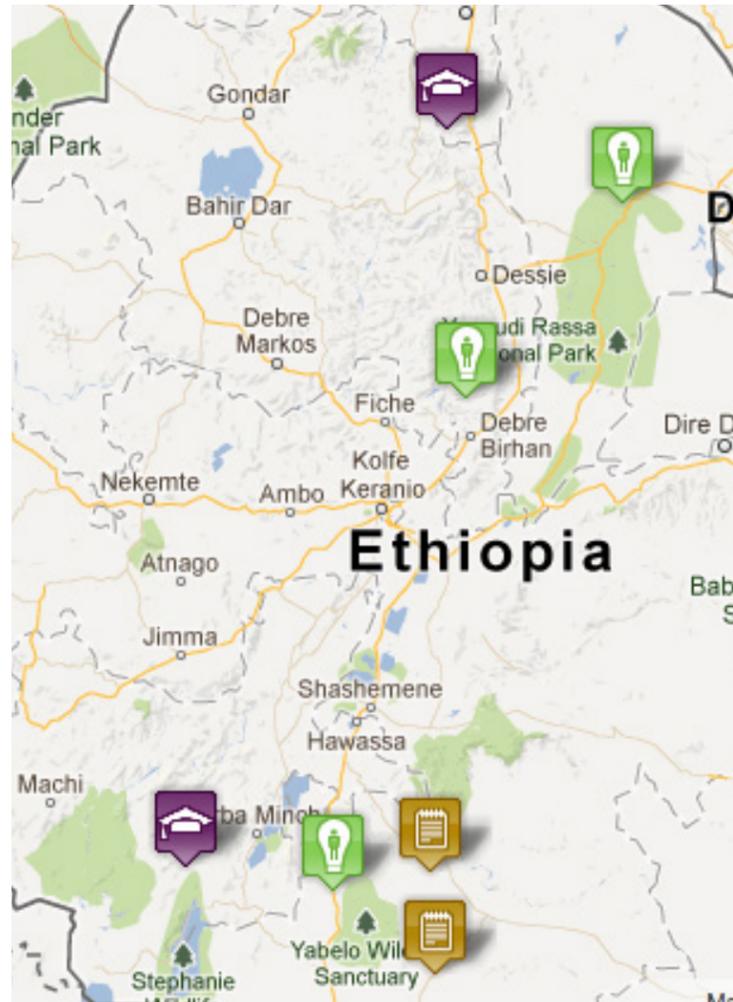
Large ruminants are affected by increasing temperatures and changes in the quantity and quality of forage.



One adaptation strategy is to switch livestock type to small ruminants.

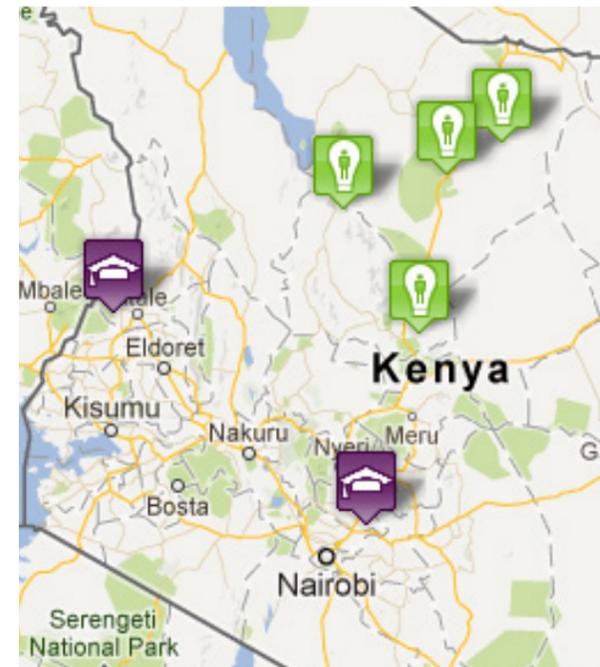


Ethiopia



Key Accomplishments

- Identified market innovations
- Published briefs and other publications
- Launched mini-grant program for early career researchers (TIRI)



Kenya

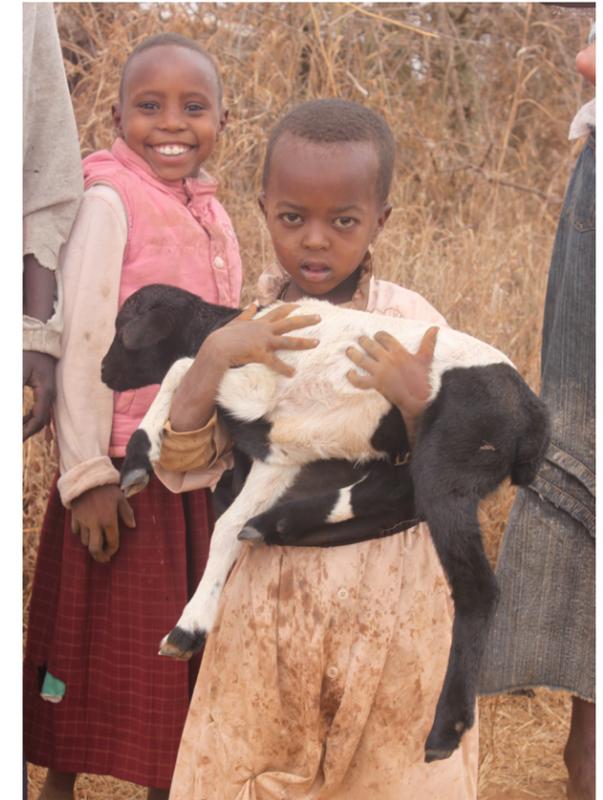


In many areas of East Africa, livestock holders are facing increasing temperatures, longer periods of drought, and heavy rains. The increasing variability in precipitation is affecting river runoff, water availability and subsequently the natural recharge of groundwater and surface water. Although current science lacks sufficient resolution to inform large-scale planning of adaptation strategies across regions, it does indicate areas of climate sensitivity. In addition to the research that we are funding on livestock market behavior under changing climatic conditions, we have also funded several early-career researchers in Kenya and Ethiopia to investigate climate impacts on disease distribution and animal health.

Research Impact: Value Chains

In Ethiopia, we are based in the Borana, a region known for its deep wells that have traditionally served as a reliable water source for people and animals during dry periods. However, as the intensity and frequency of droughts have increased, the water level in many wells has dropped precipitously. Our current research is actively dedicated to mitigating livestock loss by identifying “best-bet” strategies for herders (Coppock, 2013).

In a recent book chapter, *Pastoralism and Development in Africa: Dynamic Change at the Margins*, Peter Little of Emory University describes pastoralism as a constantly evolving livelihood system that is responsive to several dynamic forces such as international markets and mobile phone technology (Little, 2012). In research funded by our Lab, Dr. Little is collaborating with Ethiopian colleagues to provide a qualitative and quantitative assessment of market opportunities for small-scale livestock buyers and traders in an uncertain physical and commercial climate.



In areas impacted by climate change, response at the farm level can range from adjusting the number and type of livestock, to changing feed, altering health practices, modifying transhumance patterns, and diversifying livelihoods.

Above: Kenya livestock holders, photo credit: Dana Hoag

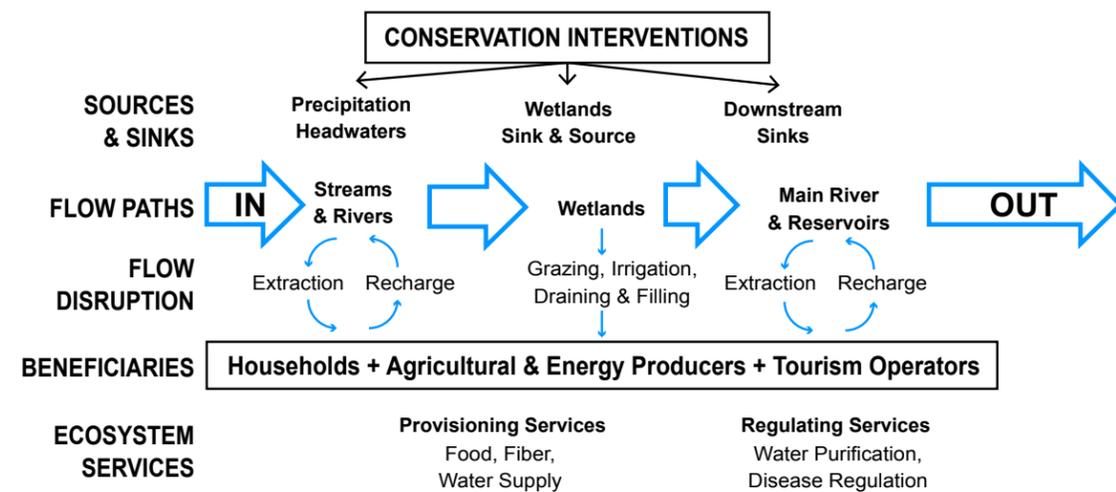
Left: Market discussions in Ethiopia, photo credit: Osman Hamden



Tanzania



In Tanzania, we support research that is focused on improving livelihoods in the Ruaha landscape where livestock production is an important source of income, wealth, and culture. University faculty and students from the U.S. and Tanzania are assessing the impact of disease and water scarcity on the health and livelihoods of pastoral communities.



Conceptual diagram of the Ruaha landscape integrated modeling framework.

Key Accomplishments

- Conducted baseline survey
- Initiated mobile phone reporting
- Initiated school curriculum on climate

Research Impact: Health Outcomes

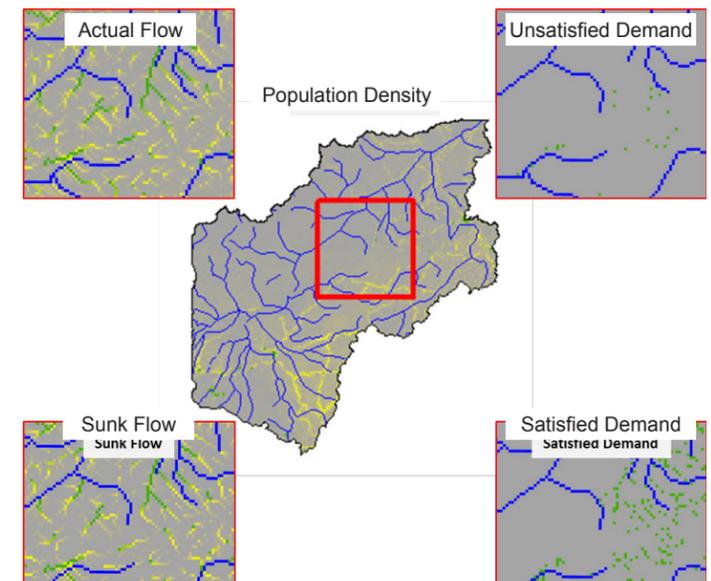
In pastoralist communities that depend on freshwater, climatic conditions are linked to changes in hydrological processes and threats to public health. Water scarcity during the dry season brings animals and people together more frequently to share water for agricultural and domestic use, thereby affecting health and food safety. Our research examines how water quality may impact health and what practices may be associated with a higher risk of disease in livestock and people. The ongoing research project is also building Tanzanian university capacity in the rapid analysis of diagnostic samples and the reliable dissemination of results.

This research project, HALI 2, led by UC Davis, is increasing the training and diagnostic capacity of Livestock Extension Officers (LEOs), creating educational opportunities for women and children, and collecting real-time data on animal health, human nutrition, and livelihoods. Researchers are using the data in their ecosystem services model to assess health outcomes of different water management decisions.

In our Innovation Lab, we continue to expand our research portfolio in Tanzania. We currently fund research on poultry education in schools in both Tanzania and Nepal. This research is focused on improving livelihoods through the integration of health and production knowledge in the daily lives of rural populations. Other organizations such as the Peace Corps are interested in adopting components of the poultry education project in their activities.



HALI-2 Team member and Dr. Barnabas Kahwage.
Photo Credit: Asha Makweta



Map of the Little Ruaha watershed with the regional population density is depicted in the center of the figure. The Actual Flow map (top left) depicts the paths of water flow between source and use locations. The Sunk Flow map (bottom left) depicts water lost to evapotranspiration and ground water infiltration. The Satisfied Demand map (bottom right) reveals locations where beneficiaries were able to access surface water supplies. The Unsatisfied Demand map (top right) identifies locations where water flow is inhibited such that it is not able to reach human beneficiaries. Enabling or restoring blocked flows may limit water shortages for these downstream beneficiaries. For each of the maps, the greener the pixel, the greater the quantity of actual surface water flow, unsatisfied demand, or satisfied demand in that location.



Senegal & Mali



The economic activities in the Sudano-Sahelian region are diverse with non-agricultural activities gaining in importance. Land-use is not only determined by subsistence agriculture but heavily influenced by migration, trade, and institutional change. Climate is a direct driver of change in this area.

Decreases in livestock have been attributed to other causes such as theft, disease, and competition with crops. Livestock producers in West Africa appear to be moving toward less climate-dependent livelihoods and increasing the percentage of their income that is derived from non-agricultural sources.

Recent political events in Mali necessitated a redirection of Mali research activities to Senegal for the near future.



Surveying pastoralists priorities in Senegal's Ferlo region for a coupled pastoral systems model (incorporating vegetation dynamics, livestock and ecohydrological sub-models, and land-use trends) to explore how climate and land-use change will impact future pastoral resources in West Africa (Hanan, 2010). Photo Credit: Peter Shapland



Research Impact: Resource Management

Our current research in Senegal explores how changes in climatic conditions are affecting the mobility patterns of pastoralists. South Dakota State University originally designed the research activities for Mali; however, recent political events required a shift in research activities to Senegal. The new area of focus in Senegal is the Ferlo, a semi-arid pastoral zone in Northeast Senegal. The SDSU researchers, in collaboration with their Senegalese partners, are collecting survey data that will be used in a coupled pastoral systems model that will help policymakers and pastoralists explore the impacts that climate and land-use change will have on pastoral resources in the future.

Syracuse University is leading a complementary research project in Senegal that is examining the services and support that riverine resources in the Senegal River Valley provide for pastoralists along transhumance corridors. The researchers are using geo-referenced data to identify key corridor points that are supported by riverine resources. The study of riverine systems is important because it provides dry season grazing reserves for herders and sources of water. An initial map of a "transhumance shed" has already been generated (see Figure 1, McPeak and Turner, 2012).

The research collaborations with new partners in Senegal have helped strengthen the Lab's regional efforts in capacity building. SDSU is strengthening regional capacity for GIS and remote sensing, while Syracuse is building capacity in the analysis of feed and forage quality. Early results from both research projects have already helped guide discussions about potential areas of conflict over limited resources along transhumance corridors. Future results promise to provide products of value to both policymakers and pastoralists.

Key Accomplishments

- Mali-based research shifted to Senegal
- Identified Senegal research priorities through a stakeholder workshop
- Conducted training for research partners in Senegal

Model of a Transhumance Shed

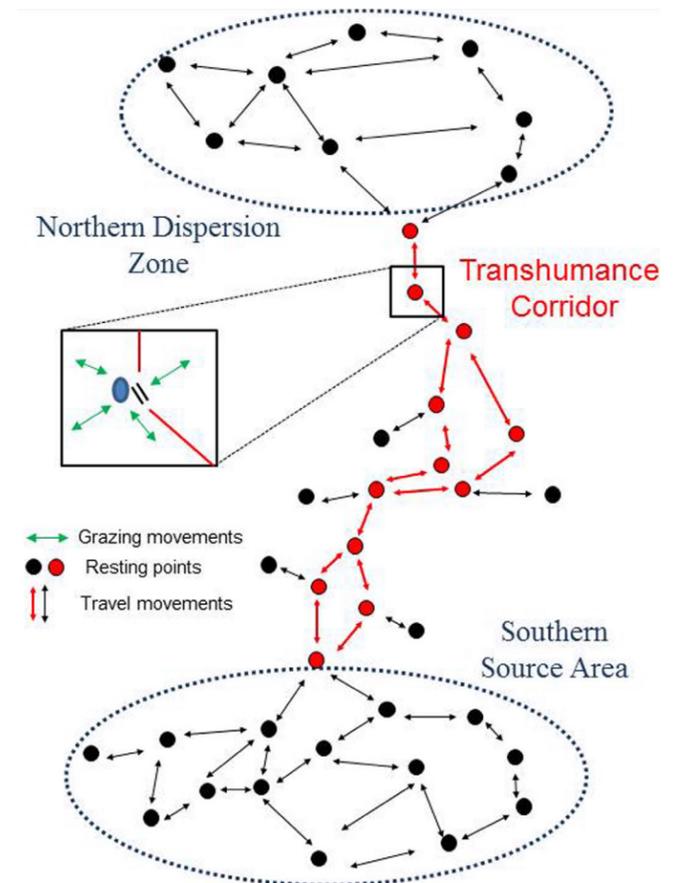


Figure 1. Within a transhumance shed, herds seasonally move between a group of home villages in the South to a Northern dispersion zone along specific corridors. The corridors consist of relatively well-defined resting points, represented by the red and black circles. Red arrows indicate points and movements that define the corridor, black indicates points and movements that feed into the corridor.

The Nexus of Gender & Nutrition

Authors: Alyson Young, Sarah Lindley McKune, Sandra Russo, Thérèse D'Auria Ryley



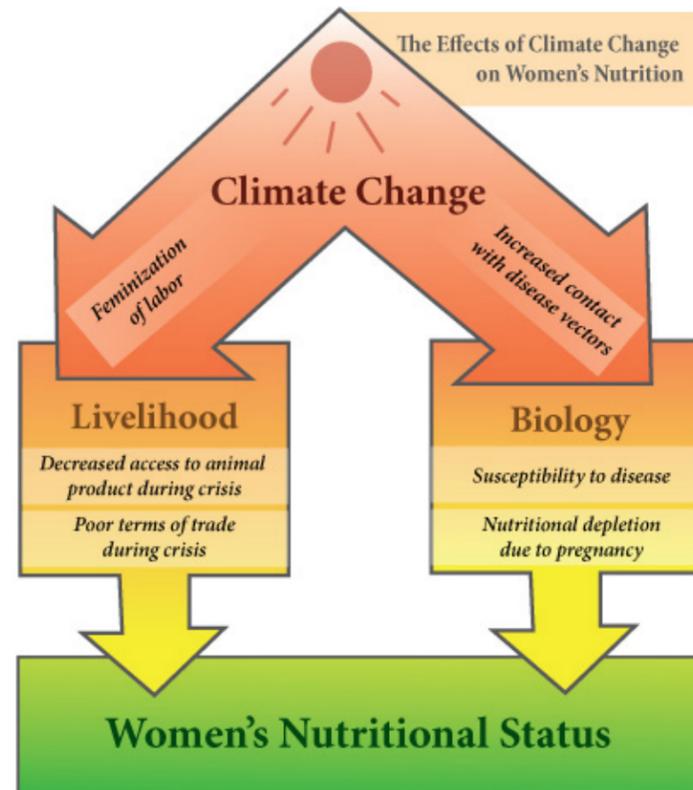
Introduction

The Nexus of Gender and Nutrition: A Literature Review addresses the interaction of climate change and nutrition within livestock holding communities. While this is a global issue, the review focuses on literature from West Africa and engages a gendered perspective. The literature indicates that certain adaptations to climate change, such as sedentarization, are potentially detrimental to the nutrition of people in livestock-holding communities, compounding the ways in which climate change directly affects health. While the authors focus on pastoralists, the review includes all those involved in livestock production in the definition of livestock holder in order to gain a more complete understanding of those affected by climate change. We look beyond calorie deficiency in our evaluation of nutritional outcomes to provide a complex illustration of the ways in which communities' nutrition is negatively affected.

Pastoralism: A Livelihood in Transition

Pastoralists have historically been the primary livestock holders in West Africa. Pastoralism is a finely tuned relationship that exists between humans, livestock, and fragile ecological systems, ecosystems often too poor to support agriculture and/or large populations. It is a livelihood whose practices, such as herding and associated mobility, are heavily embedded with cultural meaning and are significant determinants of identity. Pastoralists are severely impacted by the environmental degradation associated with climate change. Research on livestock holders in West Africa shows that rural communities not historically dependent upon livestock production have taken up the livelihood practice in recent decades, while others who have historically been nomadic herders have begun sedentarizing and initiating crop production. Women in pastoral communities are particularly vulnerable to the impacts of climate change, due to their lack of financial independence and their low social status.

Climate Change affects livelihood and health by decreasing access to resources and increasing susceptibility to disease.



Climate Change and Resilience

Despite the historically high adaptive capacity of pastoral communities to deal with environmental variability, such as drought, the increased frequency and severity of extreme events associated with climate change in West Africa are threatening pastoral resilience and leaving these communities highly vulnerable. Some livestock holders have adapted to climate change by choosing to keep different types of animals, altering patterns of mobility, and diversifying livelihood strategies. Often with the goal of maintaining livestock production as a primary livelihood activity, pastoral livelihood diversification also includes migrating to cities for wage labor and sedentarizing in

The Nexus of Gender and Nutrition

Authors: Alyson Young, Sarah Lindley McKune, Sandra Russo, Thérèse D'Auria Ryley



order to adopt agricultural activities. While some of these adaptive strategies serve to improve livelihood security, some leave pastoralists more vulnerable to future shocks. Adaptation to climate change is not gender neutral. Women are often left to perform the majority of livelihood tasks, in addition to caring for young children and the elderly, when men seek wage labor in urban areas. If and when households face hardship, women are the first to lose economic agency, either through the forced sale of personal assets or the forfeit of their engagement in markets to men. Ultimately, climate change serves to increase the vulnerability and marginalization of women in pastoral communities.

Pastoralist communities are at particular risk for undernutrition due to climate change. Climate change leads to low crop yields, which creates unfavorable terms of market trade for pastoralists, as they rely on trade of grains to rise, rendering pastoralists unable to supply their families with enough calories. Undernutrition due to low crop yields and poor livestock health is exacerbated by the high caloric output of livelihood diversification practices, particularly among women.

In addition to the vulnerability of undernutrition women are also at high risk of disease and injury. Women tend to work long strenuous days, often while pregnant, increasing risk of injury. The work of women often places them in close proximity to disease vectors, such as mosquitoes, increasing their risk of poor health. The health of the community suffers as a result of women's undernutrition, as women serve as primary caregivers. High prevalence of undernutrition and disease puts women and children at risk, including increased risk for birth defects, as well as in utero disease transmission.

Implications for Future Research & Practice

Research indicates that climate change has a gendered impact on the communities it affects, and these impacts vary depending upon livelihood practices and the environment

in which they operated. Incorporating a gendered lens into the development of policies and legislation is an ongoing process and, consequently, must be continually reincorporated when new issues arise, such as the impacts of climate change on nutrition. Gender sensitive research and program implementation must take into consideration the valuable roles of both men and women in their communities. Understanding and responding to complex problems requires consideration, input, and cooperation of all members of a community, men and women alike.

Four-Fold Impact on Livestock Holders

- Low crop yields caused by the effects of climate change lead to calorie deficiency, causing undernutrition
- Uncharacteristic changes in temperature and weather cause disease outbreak, which, via infection, exacerbated undernutrition
- The ability to perform physically demanding coping tasks required for sustainability of the livelihood is compromised by disease and undernutrition
- Occurring simultaneous to disease outbreak, undernutrition causes increased susceptibility to disease

For the complete report and a full list of references, please see, "The Nexus of Gender and Nutrition: A Literature Review", available at: lccrsp.org



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Carbon footprint

In 2012, we estimated that air travel, events, and research activities were the main GHG source for our program. We estimated GHG emissions from office operations to be less than one percent of our total emissions.

To mitigate our impact :

Air travel: We will offer offset options to participants in our events and research activities. We will manage our air travel to be as efficient as possible in the number of miles that we travel each year.

Events: We will commit to select environmentally-friendly hotel and restaurants for our events. We will print publications on demand and for special events. For general circulation, program publications will be available digitally and online. Event organizers will follow a protocol for reducing emissions at events.

We will offset any remaining emissions through small-scale agroforestry projects in Nepal and Tanzania that are near our research sites. This carbon offsetting of global emissions will occur biannually.

