Climate change adaptation in livestock systems

Brief 4: Animal Health

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Reducing the growing burden of livestock and zoonotic disease under climate change through new evidence, tools and technology and improved disease surveillance

ILRI's objectives

ILRI will support improved control of livestock disease across sub-Saharan Africa and Southeast Asia by providing policymakers and animal health professionals with new evidence, tools and technology that enable them to successfully address the growing and shifting burden of livestock disease under climate change. Outcomes include:

- Decision makers prioritize diseases and develop and deploy effective disease control strategies based on new evidence on climate change impacts on livestock and human disease.
- Tools and technical support available to countries to improve their disease surveillance and response systems in order to detect changes in disease in a timely way, thus dramatically reducing the cost of response.
- No regret adaptation responses for key climate sensitive diseases in target geographies, reducing morbidity and mortality for livestock and humans.
- New vaccines and diagnostics for climate sensitive diseases in the pipeline, with some ready for deployment and commercialization in 2–10 years.

Situation analysis

Animal and public health care systems in developing countries are poorly equipped to handle the increased disease burden driven by climate change. Already 20% of ruminants and more than 50% of poultry die prematurely each year, causing a loss of USD300 billion per year (Dinesh et al. 2015). At least half of these deaths are due to infectious diseases. Losses caused by the Rift Valley fever (RVF) outbreak that occurred in Kenya in 2006/2007 was estimated at USD32 million (Rich and Wanyoike 2010). Uganda and Rwanda are now reporting incidences of the disease. Trypanosomosis costs livestock keepers in East Africa USD2 billion per year and East Coast fever (ECF) kills one million animals in Africa per year (Dinesh et al. 2015).

The majority of the animal diseases most important to poor livestock keepers are climate sensitive. Changes in temperature, precipitation and humidity will vary geographical ranges of most of these diseases, cause major shifts in the distribution and prevalence of vectors, and increase the incidence and intensity of infectious disease epidemics (Heffernan 2018; Grace et al. 2015). Temperature changes will drive major shifts in tsetse distribution throughout Africa; in some geographies it will decline, in others increase (Grace et al. 2015). Increased frequency of extreme events such as

El Niño will drive disease incidence; in eastern Africa, the warm phase of El Niño is associated with outbreaks of many mosquito-borne diseases including RVF (Anyamba et al. 2009). Around 60 percent of all infectious diseases are zoonotic through either contact with or the consumption of animal products and byproducts (Grace et al. 2012). Food and water-borne zoonoses can be highly climate sensitive, putting livestock keepers and other populations at increased risk (Grace et al. 2015).

To prioritize, plan and implement against changes in disease burden, new analyses are needed to forecast more reliable estimates under different climate change scenarios. The effect of different futures on livestock diseases, especially on non-vector borne diseases, have received little attention. Advances in multi-variate modeling approaches, understanding of current disease distribution, regional climate projections, agricultural land cover maps, improved population maps and projections, and foresight analysis enable more systematic analysis of the dynamics of disease distribution. Key risks to assess include:

- **Co-location of climate sensitive diseases multiplies the disease burden.** Numerous climate sensitive livestock diseases may occur in common areas given that their emergence and transmission are controlled by similar ecological factors. The occurrence of a high number of diseases can overwhelm both private and public health service providers.
- **Endemic diseases shift their range, catching producers and health systems unprepared.** Local geographical shifts in vector-pathogen-host ranges have likely occurred in endemic areas, but no investigations have been done to demonstrate such changes.
- **Changes in human population and behavior magnify the impact of climate change on disease.** Land use changes that are implemented in response to climate change and variability can result in more animal and human disease. For example, these changes may result in loss of biodiversity, which increases disease risk, and/or pesticide poisoning of humans as farmers apply more pesticides in response to increased tick populations.

Vaccines and antibiotics may no longer work under the pressures of climate change, impacting the design of new disease control strategies. Many vaccines and antibiotics are more effective when administered to hosts that are immunocompetent. Increasing temperatures will reduce an animal's ability to fight off infections. Temperatures above 30°C cause a reduction in feed intake and trigger the secretion of stress hormones which suppress immunological responses. New research is needed to understand which disease control technologies will become ineffective with climate change.

Investing in no-regret animal health adaptation responses is a win-win for livestock keepers, communities, countries and regions. Trypanosomosis, RVF and ECF are three of the most serious and most climate sensitive animal pests. There are proven disease control methods that are highly cost-effective but require investments to roll out. Investing in community-based vector control for the trypanosomosis vector, risk maps and decision-support frameworks for RVF (Oyas et al. 2018; Munyua et al. 2016) and continued roll out for the infection and treatment 'vaccination' for ECF (Perry 2016) will have benefits many times the cost. Risk maps and decision-support frameworks can also be adapted for other climate sensitive diseases.

Regional, national and local organizations need support to implement quality surveillance programs in the face of shifting disease burden. Well-functioning surveillance systems and timely responses may reduce the cost of disease outbreaks by 95% (Grace 2014), but official disease reporting systems are plagued by massive under-reporting and research studies that provide more accurate information are often small, unrepresentative and dated. Organizations need accurate information on pests and disease presence, level, impacts and the costs for control. Impacts are not constrained within national boundaries; thus, response strategies should develop approaches to coordinate at the regional and continental scales. ILRI is working with partners in Kenya to roll out new satellite technology to track the impact of climate-related shocks on livestock health, such as the impacts of heavy flooding on vector-borne disease. This and other types of disease surveillance tools can be further developed and rolled out for use.

New technologies targeted at climate sensitive diseases could mediate the impacts of climate change on disease distribution and incidence. Effective diagnostics, drugs and vaccines are lacking for most climate sensitive diseases. In cases in which they do exist, high cost, strain specificity, low efficacy and lack of availability render them ineffective at reducing morbidity and mortality from disease.


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Long-term investments in new technology development, especially for multivariate and thermostable vaccines that can address multiple disease burden and remain effective in the face of rising temperatures, are needed for climate sensitive diseases important to poor livestock keepers.

ILRI's solutions

Solution 1: Determine climate change impacts on livestock and human health now and in the future

Utilize historical data sets, new in-field and research-station surveys and studies, and forecast modeling to conduct research in the following areas:

1. Ground-truth the list of climate sensitive diseases to help policymakers, researchers and donors prioritize.

2. Determine the effect of climate change on multiple climate sensitive vectors and pathogens to obtain more reliable estimates of disease burden.


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3. Determine how climate change impacts disease transmission through indirect pathways. For example, understand the potential land use changes in response to climate change and monitor impacts on animal disease to allow preventive or remedial actions.

4. Determine whether the effects of climate change on immunological responses in hosts can limit the effectiveness of vaccines and drugs, starting with ECF and RVF.

Solution 2: Support local, national and regional surveillance for upsurge in the incidence of climate sensitive diseases, especially endemic infectious diseases

1. Work with national governments to deploy standardized and systematic monitoring of climate, vectors, pathogens and diseases over multiple sites and over a long period of time to obtain evidence on the effects of climate change on disease distribution in endemically infected areas.

2. Develop standardized procedures for establishing and deploying participatory disease surveillance.

3. Develop and test innovative technologies for surveillance, including mobile phone and internet applications, and more rapid methods for processing and analyzing data.

Solution 3: Develop decision support and use tools to guide the deployment of interventions

1. Develop risk maps and decision support frameworks for climate sensitive diseases.

2. Update recommendations and manuals on tick control based on projections of changes in prevalence and tailor them to environments and production systems.

3. Update recommendations and manuals on judicious use of trypanocides to control trypanosomosis based on projections of changes in prevalence and tailor them to particular environments and production systems.

4. Support the roll out of community-based vector control for the trypanosomosis vector through assessments of the incentives and economic impacts of different approaches.

Solution 4: Develop new disease control technologies for climate sensitive diseases, including vaccines and diagnostics tests, and strategies for their deployment.

1. Develop vaccines for climate sensitive diseases important to the poor.
   - Continue development of the new RVF vaccine that will work for both humans and animals, opening up unique delivery pathways.
   - Continue development of the ECF sub-unit vaccine, currently in proof-of-concept stage with approximately five years to deployment, which will be more sustainable than the currently available technology because it is thermostable and less expensive.
   - Develop new multivalent vaccines that can confer immunity to multiple diseases.
   - Develop thermo-tolerant vaccines that do not require cold-chain.

2. Develop diagnostics for climate sensitive diseases important to the poor including a rapid test kit for RVF, a diagnostic kit for cysticercosis and multiplex diagnostics for bundles of climate sensitive diseases.

3. Develop use manuals for the new technologies, including how to deploy in specific production systems and within a population of animals, community of producers and countries/regions.

4. Work with public and private sector partners to develop manufacturing, commercialization (when appropriate) and roll out plans for each technology.

Roll out ready tools: Risk maps and decision support tools for Rift Valley fever and other climate sensitive diseases

ILRI will work with national stakeholders in Uganda and Rwanda to develop and roll out risk maps and decision support frameworks for RVF, thus reducing what could be huge economic and human health tolls from the increased outbreaks expected with climate change.

The RVF risk maps and decision support framework have been successfully deployed in Kenya (Oyas et al. 2018; Munyua et al. 2016) and are ready for roll out in other countries. The risk maps classify areas as high, medium or low risk. The decision support framework provides a roadmap for 1. Deciding where to establish sentinel surveillance among humans and livestock for early warning in compliance with the WHO international health regulations; 2. Setting up long-term disease prevention and control programs in livestock such as vaccination and public education; 3. Initiating mitigating actions in response to a forecasted epidemic; and 4. Raising the suspicion index and setting up appropriate diagnostics in human health facilities to look for cases during epidemic and inter-epidemic periods (Consultative group for RVF decision support 2010).

In addition to further rolling out the RVF tools, ILRI will work in partnership with national, regional and international players to adapt these tools for other climate sensitive diseases.

ILRI's impact and capacity

Strong research program in Animal and Human Health implemented by multidisciplinary teams of experienced and highly trained researchers specializing in epidemiology, immunology, biotechnology, diagnostics and One Health approaches. The teams operate in multiple countries in sub-Saharan Africa and Southeast Asia, working at country and regional levels to deliver critical analyses and tools to producers and policymakers.

World class facilities for lab and field-based research and technology development, including Biosciences Eastern and Southern Africa (BecA), the ILRI Vaccine Platform (ILVAC), and Kapiti Ranch.

Strong country level relationships across sub-Saharan Africa and Southeast Asia that open the door for capacity building efforts on disease surveillance and control.

Lead institute globally researching RVF. Delivered critical RVF decision tools that are already helping policymakers confront the disease.

Developed and deployed the ECF infect and treat method, with extensive and positive benefits for livestock farmers. In addition, ILRI is engaged in ongoing work on new vaccines for ECF and RVF as well as other sub-unit vaccines and on several disease diagnostic tools.

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ILRI thanks all donors that globally support its work through their contributions to the CGIAR Trust Fund

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March 2019