Studies of zoonoses in dynamic livestock systems in Kenya

Eric Fèvre
Professor of Veterinary Infectious Diseases, Institute of Infection and Global Health, University of Liverpool, UK and International Livestock Research Institute, Nairobi, Kenya
Eric.Fevre@liverpool.ac.uk; www.zoonotic-diseases.org; Twitter: @ZoonoticDisease

Visit by Sir Mark Walport to ILRI, 15 July 2015
The investment

**ESEI**: Environmental and Social Ecology of Human Infectious Diseases (ESEI) initiative

**ZELS**: Zoonoses in Emerging Livestock Systems programme

Wellcome Trust and the CGIAR

The Leverhulme Centre for Integrated Research on Agriculture and Health

**ILRI** in partnership with several institutions

**University of Liverpool** Institute of Infection and Global Health
The partners
The people

- **Postdocs:** Pablo Alarcon, Sohel Ahmed, Annie Cook, Judy Bettridge, John Kiiru, Melissa Ward, Joshua Onono

- **PhD students:** Lian Thomas, Laure Madé, James Hassell, Stella Kiambi, Maud Carron

- **MSc students:** James Akoko, Maurice Karani, Patrick Muinde, Mercy Cianjoka, Joseph Ogola, James Machiaria, Isaac Ngere, Maurice Omondi, Caren Ndeta

- **The team:** Victora Kyallo, James Akoko, Omoto Lazarus, Lorren Alumasa, Daniel Cheriyot, Jenipher Ambaka, Fred Opinya, John Mwaniki, Hannah Kariuki, Gideon Mwali, George Omondi, Alice Kiyong’a, Lilian Abonyo, Maseno Cleophas, Fred Ambaka, Velma Kivali, Fred Amanya, Allan Ogendo, Nduhiu Gitahi, Dishon Muloi, Maurice Karani, Patrick Muinde, Evaristo Malenge

- **Collaborators:** Cecilia Tacoli (IIED), Erastus Kang’ethe (UoN), Sam Kariuki and Njeri Wamae (Kenya Medical Research Institute, KEMRI), Mark Woolhouse (UoE), Bernard “Risky” Agwanda (NMK), Mark Bronsvoort (Roslin Institute), Jonathan Rushton, Pablo Alarcon and Claire Okell (Royal Veterinary College), Catherine Kyobutungi and Djesika Amendah (APHRC), Julio Davila and Adriana Allen (DPU, UCL), Delia Grace, Phil Toye, Tim Robinson, Steve Kemp (ILRI), Heinrich Neubauer, Lisa Sprague (FLI), Dorte Dopfer (UW Madison), Greg Gray (Florida), Desiree LaBeaud (CHORI)….

- **The Department of Veterinary Services Kenya, the Zoonotic Diseases Unit (Eric Osoro, Austine Bitek), Kenya**
Demographic change

• Massive increases in the population of urban and peri-urban (UPU) zones in Africa
  – From 35% of total population 2007 to 51% by 2030

• Kenya: ~35 major poles of urbanization

• Impacts on
  – human welfare
  – healthcare provision and delivery
  – sanitation
  – demography
  – economics
  – trade
  – development
  – food production
  – planning
  – disease transmission
Figure 38 - The total consumption of livestock products (tons 000s) in different regions of sub-Saharan Africa to 2050 by SSP scenario.


Integrated zoonotic disease surveillance and reporting

<table>
<thead>
<tr>
<th>Brucellosis</th>
<th>Anthrax</th>
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</thead>
<tbody>
<tr>
<td>Leptospirosis</td>
<td>Q fever</td>
</tr>
<tr>
<td>Trypanosomiasis</td>
<td>TB</td>
</tr>
<tr>
<td>Echinococcosis</td>
<td><em>Salmonella</em> spp. including AST</td>
</tr>
<tr>
<td>Rift Valley Fever</td>
<td><em>E. coli</em> including AST</td>
</tr>
<tr>
<td><em>T. solium/T. saginata</em> cysticercosis</td>
<td><em>Campylobacter</em> spp. including AST</td>
</tr>
<tr>
<td>Fascioliasis</td>
<td><em>Staphylococcus</em> spp. including AST</td>
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Field site

- Lake Victoria Crescent ecosystem:
  - Small-holder crop-livestock production system
  - Approximately 70% of households in the region keep livestock
- Close collaboration with: National and County gov’t
Zoonoses in context: Key sources of epidemiological data

Hospitals, markets, slaughterhouses, butcheries, household tracebacks

Figure 3: Spatially smoothed relative risks of Q fever seropositivity in humans (left panel) and cattle (right panel).
Improved diagnostic platforms for zoonoses detection

High-throughput, multiplexed laboratory assays
Pen/bed-side assays
AMR in changing livestock system

<table>
<thead>
<tr>
<th>Test</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>PPV (%)</th>
<th>NPV (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAT</td>
<td>81.8 (43.3 - 99.5)</td>
<td>80.6 (77.8 - 83.2)</td>
<td>3.7 (1.2 - 7.3)</td>
<td>99.8 (99.3 - 100)</td>
</tr>
<tr>
<td>RBT*</td>
<td>96.6 (89.1 - 99.8)</td>
<td>99.4 (98.7 - 99.8)</td>
<td>58.6 (29.8 - 86.2)</td>
<td>100 (99.9 - 100)</td>
</tr>
<tr>
<td>SAT</td>
<td>66.4 (39.4 - 89.0)</td>
<td>99.8 (99.4 - 100)</td>
<td>74.5 (40.1 - 96.6)</td>
<td>99.7 (99.2 - 99.9)</td>
</tr>
<tr>
<td>Coombs test</td>
<td>88.6 (64.7 - 99.7)</td>
<td>99.8 (99.4 - 100)</td>
<td>79.2 (48.4 - 97.4)</td>
<td>99.9 (99.6 - 100)</td>
</tr>
</tbody>
</table>

*Using results from confirmatory tests performed at the University of Navarra
Livestock husbandry, marketing, population dynamics and population genetics

Study of livestock marketing and livestock population dynamics
Livestock genetics and genetic change
Predicting the future....

- Value chain approach, demographic and consumption models, scenario analysis
- Forward projections of population growth, urbanisation, land use, consumption patterns and changing demand for animal source foods
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Sampling across socio-economic groups

99 households:
~30 sublocations (n=70)
Across 10 socioeconomic classes
3 households per unit
Landscape genetics

- Bacterial isolates
- Characterize and quantify genetic diversity on 000’s of isolates
- Whole Genome Sequencing
- Build genetic/geographical maps of microbial diversity
Cooking up a storm
Community-led mapping and advocacy with food vendors in Nairobi’s informal settlements

Sohel Ahmed, Edwin Simiju, Grace Githiri, Alice Sverdlik and Shadrack Mbaka
Modelling frameworks for optimised surveillance

- What are the minimum requirements for routine data?
- Intelligence-driven approach to identify and quantify risk factors for presence of a zoonotic infection in individuals and the population
Costs of surveillance

Cost and cost benefit of surveillance system
Decision support for local and national government
Thanks for your attention!

Eric Fèvre
Email: Eric.Fevre@liverpool.ac.uk

Web: www.zoonotic-diseases.org
Twitter: @ZoonoticDisease

Tel (VOIP): +44 151 324 1241
Tel: +254 722 545 345

Institute of Infection and Global Health
University of Liverpool
Leahurst Campus
Neston
CH64 7TE
United Kingdom
UK

International Livestock Research Institute
Old Naivasha Road
Po Box 30709-00100
Nairobi
Kenya