An integrated approach to controlling brucellosis in Africa

Workshop report

29-31 January 2013

Addis Ababa, Ethiopia
An integrated approach to controlling brucellosis in Africa

Workshop report

Workshop sponsors

United States Department of Agriculture (USDA)
United States Department of Agriculture-Agricultural Research Service (USDA-ARS)
United States Agency of International Development (USAID)
International Livestock Research Institute (ILRI)

Workshop organizers

Eileen Thacker (Organizing committee – USDA-ARS)
Joyce Turk (Organizing committee – USAID)
Delia Grace (Organizing committee – ILRI)
Eileen Herrera (Organizing committee – USDA-ARS)
Irlene Santos (USDA-ARS)
Isaiah Akuku (ILRI)
Rosekellen Njiru (ILRI)

Acknowledgement

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# Acronyms and abbreviations

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<th>Full Form</th>
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<tr>
<td>APHIS</td>
<td>Animal Plant Health Inspection Service</td>
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<tr>
<td>ARS</td>
<td>Agricultural Research Service</td>
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<tr>
<td>AU-IBAR</td>
<td>African Union – Interafrican Bureau for Animal Resources</td>
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<tr>
<td>BecA</td>
<td>Biosciences eastern and central Africa</td>
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<td>BSL</td>
<td>Biosafety Level</td>
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<tr>
<td>CDC</td>
<td>Centers for Disease Control and Prevention</td>
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<tr>
<td>CNERV</td>
<td>Centre National d’Elevage et de Recherches Vétérinaires</td>
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<tr>
<td>CSRS</td>
<td>Centre Suisse de Recherches Scientifiques</td>
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<tr>
<td>CVL</td>
<td>Central Veterinary Laboratory</td>
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<tr>
<td>DIVA</td>
<td>Differentiating Infected from Vaccinated Animals</td>
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<tr>
<td>ELISA</td>
<td>enzyme-linked immunosorbent assay</td>
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<tr>
<td>HPAI</td>
<td>highly pathogenic avian influenza</td>
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<td>ILRI</td>
<td>International Livestock Research Institute</td>
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<td>KEMRI</td>
<td>Kenya Medical Research Institute</td>
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<tr>
<td>PCR</td>
<td>polymerase chain reaction</td>
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<td>RVF</td>
<td>Rift Valley fever</td>
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<td>USAID</td>
<td>United States Agency for International Development</td>
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<tr>
<td>USDA</td>
<td>United States Department of Agriculture</td>
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<tr>
<td>WHO</td>
<td>World Health Organization</td>
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<td>ZDU</td>
<td>Zoonotic Disease Unit</td>
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Introduction and objectives

*Brucella* spp. infects multiple animal species, including cattle, pigs, small ruminants, camels, water buffaloes and yaks. Different species of *Brucella* infect different animal species, but most have the potential to infect humans, with some species of the organism causing more disease than others. *Brucella* infection rates in some developing countries can reach greater than 10% of the human population, making it a serious public health disease. *Brucella* causes disease in animals, impacting production, causing abortions in pregnant females and reducing male fertility. The most common method by which humans are infected is through ingesting unprocessed milk products from infected animals. However, direct contact with infected animals and meat can also be a source. Therefore, the goal of this workshop was to work with appropriate personnel to develop improved diagnostic surveillance techniques and control strategies for livestock on a country basis. Specific topics that were covered included:

- Transmission of infection from animals to humans (public health)
- Epidemiology: prevalence, impacts and transmission among animals
- Laboratory biosafety practices
- Diagnostic assays: serology and organism identification to assist in developing surveillance programs
- Vaccination strategies
- Policy

In addition, potential research collaborations for *Brucella* were investigated. Collaborative research will provide long-term engagement programs for improving the control of brucellosis in the various countries and provide important support to scientists working on *Brucella*. The workshop provided the organizers and participants with critical information on this frequent human pathogen contracted from domestic animals.

The anticipated outcomes of the meeting included:

- Knowledge and understanding of the status of *Brucella* surveillance and control in the participating African countries
- Identification of gaps in surveillance, monitoring and control in animals
- Potential strategies to begin implementing surveillance and possible control strategies

Participants

There were 69 participants including the organizing committee and invited speakers. The participants and organizers were from 16 countries, 13 of which were in Africa. The list of participants is included in Appendix 1.

Overview of the workshop

A copy of the workshop agenda is included in Appendix 2.
Day 1, Tuesday 29 January 2013

The meeting was opened with welcoming remarks from Eileen Thacker as the head of the organizing committee, Azage Tegegne representing CGIAR (for ILRI), Abdelkhalik Montasser for the African Union – Interaficn Bureau for Animal Resources (AU-IBAR), Eileen Herrera for USDA–ARS and John Graham for USAID.

The morning session included overviews covering all aspects of brucellosis that would be the topic of discussion throughout the workshop. Online links to the presentations are included in Appendix 4.

**Eileen Thacker** gave an introductory presentation on "Brucellosis: The bugs and the disease". The history, clinical signs, treatment and basic control strategies were covered with the take-home message that to prevent brucellosis in humans, we must eradicate it from animal populations.

**Steve Hennager** gave a presentation on the "Differential diagnosis of brucellosis serological reactions". He discussed antibody detection assays for milk and serum and the positive and negatives of each type of test.

**John Kaneene** presented on the "Epidemiology of brucellosis in ruminants: The basics and dynamics of the disease". He discussed the host ruminants as well as the reservoir hosts that can maintain and transmit the infection to other species. He discussed modes of transmission, both to other animals and humans. Outbreak investigations and the steps needed to conduct a successful investigation were covered. He concluded with outbreak control and monitoring methods to evaluate the effectiveness of the control measures.

**Anani Adeniran Bankolé** presented on "Brucellosis risk assessment". He discussed using risk analysis as a tool to provide decision-makers with an objective and documented assessment. Risk assessment requirements for brucellosis included imports (commodities), surveillance (also related to importation), microbiological assessment for food safety, and human infection (primarily from food).

**Steven Olsen** gave a presentation on "Beneficial approaches for controlling brucellosis". In his presentation, he discussed the components of a control program which would include surveillance, vaccination, quarantine or removal of infected animals (risk reduction), sanitation, trained personnel, complete and accurate records, movement control and regionalization of the control. He noted that usually vaccination for Brucella is controlled and vaccination alone will not eradicate brucellosis. He also discussed the basics of the other control strategies listed above. He summarized brucellosis control strategies as needing to be coordinated and committed within a regulatory framework. The benefits of control include reduced human disease, greater economic returns for livestock owners and possible trade opportunities.

**Bassirou Bonfoh** gave a presentation on the "Economics of brucellosis". He discussed the ongoing research on brucellosis in his institute (Centre Suisse de Recherches Scientifique, CSRS) and the importance of livestock in assisting people to get out of poverty and providing protein. He covered possible methods to determine the economic considerations and the link of disease data to production and human health costs. The presentation included a very comprehensive discussion about the economic cost/benefit of controlling brucellosis.

**Joseph P. Kozlovac** presented on "Laboratory biosafety and biosecurity issues related to Brucella research and diagnostics". Since brucellosis is the most common laboratory acquired infection, he discussed the types of safety techniques and equipment needed for diagnostics and research. This included defining safety risk groups and measures to control aerosol spread. He also discussed personal protective equipment, occupational health and surveillance measures that could also help minimize the risk of infection to laboratory workers.
Stella Kiambi discussed “One Health units and brucellosis in Kenya”. In her presentation, she began by describing Kenya’s geographic and demographic statistics, including the number of animals in the country. She defined One Health as “the collaborative efforts of multiple disciplines working locally, nationally and globally to attain optimal health for people, animals and the environment” (AVMA 2007). She went on to discuss how many diseases are zoonotic in nature and therefore, the Zoonotic Disease Unit (ZDU) has been established to collaborate on controlling these diseases. The ZDU is a joint effort by the Kenyan Ministries of Public Health and Sanitation, and Livestock Development. The ZDU has been conducting a study of brucellosis using a seroprevalence survey in animals and humans to identify the factors of infections and determine the socio-economic impact of the disease in both populations. They are currently in the first phase of the study and it is going well.

Abdelkhalik M. Montasser gave a presentation on “Background of AU-IBAR and brucellosis: Past, present and future in the Middle East and Africa”. He discussed the mission/mandate and goals of AU-IBAR in providing leadership and support in the development and utilization of animals to enhance economic growth, food and nutrition security and poverty reduction in Africa. AU-IBAR’s strategic programs include reducing transboundary and zoonotic diseases, conserving and sustaining natural resources, improving investment and competitiveness of animal resources, improving knowledge management and facilitating development of policies and institutional capacities for improving animal resource utilization. He provided interesting statistics on brucellosis in Africa where 40 of 54 African countries are known or suspected to be positive, 20 countries consider it a major problem, 10 a moderate problem and 10 a minor problem. All Middle Eastern countries have brucellosis so regional control is needed. He reiterated the need for improved surveillance and control, primarily through vaccination. In conclusion, he discussed possible future control strategies that would be important to improve the overall health of animals and humans.

Delia Grace provided an “Overview to the Meeting”. She discussed how brucellosis had been identified in early skeletal remains in South Africa and has remained a problem since. Africa is an agrarian society with many farmers, livestock and consumers, and meat is a preferred source of protein. Women play an important role in livestock farming, and wildlife is uniquely important and can be a risk. Overall, there is a high level of apparent disease yet low levels of reporting. There have been over 800 studies on brucellosis in Africa with an average prevalence in animals of 10.5% and 8% in humans. Brucella has been isolated from almost every species of animal. The goal of this workshop was to begin identifying the gaps in knowledge and share experiences in strategies that work and those that haven’t been successful. She hoped that the workshop would lead to plans, proposals and new investments in addressing brucellosis in Africa.

After the opening session in the morning, the participants attended two breakout sessions. The first session had four breakout groups, namely,

- Diagnostics: Serological screening tests;
- Epidemiology: Large ruminants;
- Vaccination and control for small ruminants; and
- Biosafety.

The second session had three breakout groups:

- Diagnostics: Confirmatory tests;
- Epidemiology: Small ruminants; and
- Vaccination and control for large ruminants.

Summary reports of the breakout sessions are included in Appendix 3.
Day 2, Wednesday 30 January 2013

The second day started with a general session focused on research. The research plenary session was opened by Eileen Thacker who welcomed the participants back to the meeting. This was followed by presentations from a few selected speakers:

Steven Olsen provided an overview of his research on brucellosis. He discussed cattle and bison vaccine work, Brucella in feral swine and the differences in the immune responses to vaccines he has found with different species of ruminants.

John Kaneene discussed an “Overview of Michigan State University brucellosis research in Africa”. He has performed research in Ghana, Tanzania and Uganda. His research in Uganda included a “Comparative study of brucellosis in livestock and humans in southwestern Uganda” in collaboration with Makerere University. In Tanzania, his research was on “The prevalence of brucellosis in cattle, goats and humans in Naitolia, Northern Tanzania” in collaboration with Sokoine University of Agriculture. In Ghana, the research was “A Comparative study of brucellosis in local and imported cattle breeds” with the University of Ghana, Noguchi Memorial Institute for Medical Research.

Eric Fèvre and William de Glanville presented on research on zoonoses in western Kenya and surprising results from investigations on brucellosis prevalence. Fèvre discussed a study in the western Kenya where smallholder crop-livestock production systems were sampled intensively and comprehensively over a 2.5 year period. He showed a very detailed sample flow chart for collecting and recording samples from the field and slaughter houses. A cross-sectional survey was conducted – sampling cattle, pigs and goats in approximately 450 households – along with a questionnaire. Full clinical examinations were performed which included collection of blood and serum and faeces along with biobanking material for genetic studies. In collaboration with the Kenya Medical Research Institute (KEMRI), an additional cross-sectional study of human samples was conducted from people that did and did not live with livestock. De Glanville reported on a serological study for brucellosis using a lateral flow assay as a primary screening test. In the study, 2116 people and 893 cattle were tested for Brucella antibodies. In these studies, brucellosis appeared to have a low incidence and it was suggested that the incidence of brucellosis was being over diagnosed.

Edward Ssekawojwa, Uganda, presented on “Risk factors for Brucella seropositivity in cattle, goats and humans in Mbarara”. Mbarara is a major livestock producing area with both pastoral and agro-pastoral types of livestock management systems. In the study, 1535 cattle and 812 goats from 98 farms were tested. In addition, 161 humans from Brucella-positive farms and 168 individuals from Kampala were tested serologically. Animal samples were screened using the Rose Bengal assay with confirmation using a cELISA test. Human samples were tested using plate and standard tube agglutination tests and the cELISA. The percentages of positive animals and herds were reported. It was determined that several factors – including a pastoral production system, herd size and incidence of abortion – were risk factors for livestock. Consumption of raw, unboiled milk was significantly associated with seropositivity in humans. Recommendations to reduce the incidence of human brucellosis included public awareness, discouraging the consumption of raw milk and addressing the pastoral production system.

Tujuba Jergefa Oncho presented on an epidemiological study of bovine brucellosis in Ethiopia. The level of brucellosis in Ethiopia is not well established due to conflicting reports. The study included three districts in Ethiopia and consisted of sampling local cattle over six months of age. The study included serum from 1238 animals and 176 households across three types of environment: lowlands, mid highlands and highlands. Rose Bengal plate and complement fixation tests were used to assay the samples. A questionnaire was included in the study. The study found that the overall seropositivity of bovine Brucella was low but varied by region. Breed and management practices were found to be important risk factors. There was low public awareness of brucellosis and clinical disease. It was recommended that a comprehensive and coordinated epidemiological study be performed in Ethiopia.
to formulate a policy. In addition, regular testing of animals, testing and culling practices, and increased education are needed.

William Mwebembezi presented a case study on the “Prevalence of antibodies against Brucella among breeding goats in relation to source”. The government of Uganda has a program to supply breeding goats. There has been past evidence of Brucella in the area, so it was proposed to carry out an audit and recommend animals for purchase. The objective was to screen potential breeding goats for brucellosis and to compare the prevalence of infection between goats obtained from markets and those from farms. Goats in the study were identified by ear tags and tested for Brucella by the Rose Bengal plate test. A total of 7739 goats were tested and 13.4% were positive. There was a wide range in disease prevalence and source of goats was found to influence disease status, with goats from markets having a higher percentage of seropositivity.

After the plenary research session in the morning, two additional breakout session periods were held, with a repeat of the sessions held the previous day to enable participants to attend as many different sessions as possible. The reports of the breakout sessions are included in Appendix 3.

On the final day, 31 January, the session was chaired by Bassirou Bonfoh from CSRS. Presentations were given by representatives of the three organizing institutes.

**USDA: Eileen Thacker**

The way forward following this workshop has to be directed by the African participants. USDA does not have a program specifically for supporting international research, but it has a program on international co-operation. Through this program, funding sources can often be identified for developing collaborations. The USDA Animal Plant Health Inspection Service (APHIS) can provide support and training. Brucellosis is very important to the USDA. From past experience, we know eradication is not easy. Participants can count on USDA support as they go forward.

**USAID: Joyce Turk**

She thanked the participants for their energetic and enthusiastic participation in the workshop which demonstrated their serious interest as well as willingness to learn from each other and work together. USAID employs one veterinarian in headquarters in the Disaster, Conflict and Humanitarian Assistance office as well as Yirgelem Gebremelski in USAID Addis, Jeffrey Austin and Andrew Clark in the East Africa Regional office, Nairobi and Connie Bacon in the West Africa regional office, Senegal.

Bilateral USAID offices fund country-specific programs that align with Feed the Future country strategies, a few of which have livestock components. USAID Washington funds a collaborative livestock research program, *Adapting Livestock Systems to Climate Change*, which is funding two Ethiopian and six Kenyan early career research scholars. Two of them are doing research on brucellosis. Although USAID funds specific country-level projects, participants were encouraged to contact or link with the USAID veterinarians named above for more specific technical or program design support.

**ILRI: Delia Grace**

ILRI is an international research organization that works with developing country partners to increase the benefits of livestock to poor people and mitigate the risks associated with livestock, including zoonoses. As such, ILRI is not a donor organization but can work with partners to jointly develop research proposals and seek funding. ILRI leads a major CGIAR research program on “More meat, milk and fish by and for the poor”. This focuses on nine value chains and for four of these, brucellosis is a major constraint (dairy in Tanzania, dairy in India, shoats in Mali and shoats in Ethiopia). ILRI also is involved in another CGIAR research program which is led by the International Food Policy Research Institute in Washington DC; ILRI leads the component on prevention and control of agriculture-associated diseases.
Region/country working groups

The next part of the session consisted of presenting group work by countries or regions. Each group was asked to identify their top two priorities in the following areas:

1. Technical cooperation and capacity strengthening
2. Research and evidence generation
3. Coordination, networking and knowledge sharing

**Ethiopia**

Technical cooperation and capacity strengthening
1. Technical training especially in the areas of biosafety, biosecurity, equipment and diagnostics
2. Ethiopia has several existing laboratories and regional and international collaborations should be developed for capacity strengthening

Research and evidence generation
1. Epidemiological mapping of brucellosis prevalence, subtypes and risk factors
2. Studies on the socio-economic impacts of disease including public health inputs

Coordination, networking and knowledge sharing
1. Linkage nationally among ministries of education, agriculture and health; research institutes; health centres and development partners and regional linkages with East African countries with a focus on transboundary animal diseases
2. Establish a national forum for zoonotic disease from community to policymakers following the model of avian influenza and share the experience of Kenya

**Kenya**

Technical cooperation and capacity strengthening
1. Encouraging collaboration between medical and veterinary sectors. It was notable that veterinary diagnostics are more advanced than those used by human health. One Health collaboration could include discussion about shared resources.
2. Training in epidemiology and diagnostics for technicians and academics; expanded to workshops and scientific meetings; One Health; needs assessment to identify areas.

Research and evidence generation
2. Evaluating and validating rapid test kits within the Kenya.

Coordination, networking and knowledge sharing
1. Joint programs which could involve major stakeholders e.g. KEMRI, ILRI, Ministry of Health, Ministry of Agriculture. Could have a body to help link partners on brucellosis.
2. Establish regional collaborations and can use the model of the rabies group.

**Uganda**

Technical cooperation and capacity strengthening
1. Technical cooperation involving technical assistance, equipment, diagnostic kits, consumables and protective gear
2. Capacity building in epidemiology and diagnostics in human and animal professionals

Research and evidence generation
1. National epidemiological study on brucellosis in human and animals in Uganda (baseline survey, risk assessment, risk mapping, bacteriological isolation and profiling)
2. Evaluation of brucellosis diagnostic tests and vaccines

Coordination, networking and knowledge sharing
1. Establish and operationalize a brucellosis communication strategy
2. Establish and operationalize a One Health Secretariat in Uganda, with brucellosis as an entry point; can share information in one centre and be a point for collaboration and planning activities

Tanzania
Technical cooperation and capacity strengthening
1. Skills for surveying brucellosis in the ecosystems of Tanzania: detection (field personnel); diagnosis (laboratory personnel); biosecurity and biosafety; reporting (information flow); response to findings; inter-laboratory cooperation (local, regional and international reference labs)
2. Training in socio-economic aspects of brucellosis

Research and evidence generation
1. Study on ecology of brucellosis in various ecosystems in Tanzania: including livestock and wildlife and producing maps according to biotypes
2. Establish social economic drivers of the disease and the impact of the disease on livestock (productivity) and human (burden)

Coordination, networking and knowledge sharing
1. Sharing of technical information among stakeholders, development partners through publication joint meeting, seminars.
2. Enhance joint collaborative activity among key players/ one health approach.

West Africa (Côte d’Ivoire, Togo, Senegal and Mauritania)
Technical cooperation and capacity strengthening
1. Training on epidemiology including sample collection, analysis and interpretation
2. Capacity building of diagnostic capability and improving access to laboratory supplies

Research and evidence generation
1. Longitudinal epidemiological surveys in representative areas with maps and collection of economic data
2. Identification of pathogens present and biovars

Coordination, networking and knowledge sharing
1. One Health strategy for brucellosis and other zoonoses in West Africa
2. Mechanisms to improve communication between researcher and decision maker on true prevalence and impact. There is potential to use the Economic Community of West African States as a framework as there is a specialized commission with a mandate for zoonoses

Nigeria
Technical cooperation and capacity strengthening
1. Upgrading of laboratory facilities and provision of equipment and reagents
2. Training of personnel in current diagnostic techniques and biosafety. (There is work going on at many labs but not all are able to effectively conduct research)

Research and evidence generation
1. Using a nationally coordinated brucellosis survey design, determine baseline data for animal brucellosis in the country. This will include determining and characterizing the circulating Brucella species/biovars
2. Determine the burden of brucellosis in humans presenting with febrile conditions in hospitals and in those occupationally at risk

**Coordination, networking and knowledge sharing**
1. Formation of a brucellosis working group in Nigeria.
2. Usage of all means of communication for sharing of research findings and knowledge among stakeholders

**Egypt, Somalia and South Africa**

**Technical cooperation and capacity strengthening**
1. Establishment of a reference laboratory for brucellosis in Africa
2. Harmonization of brucellosis control and strategies between neighbouring countries and sharing resources and training

**Research and evidence generation**
1. Biotyping and mapping of brucellosis and using the information for choosing vaccines
2. Investigating the relationship between the disease in animals and people

**Coordination, networking and knowledge sharing**
1. Establishment of good networking between peripheral and central veterinary units for early reporting
2. Raising awareness about the disease among the wider community and giving information on how to reduce risk
Summary of priorities

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<tr>
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<th>Capacity building</th>
<th>Research</th>
<th>Coordination</th>
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<tbody>
<tr>
<td>Ethiopia</td>
<td>Diagnostics Laboratory</td>
<td>Surveys Socio economics</td>
<td>Link sectors One Health forum</td>
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<tr>
<td>Kenya</td>
<td>One Health Epidemiology &amp; diagnostics</td>
<td>Surveys Rapid tests</td>
<td>Joint programs Regional collaboration</td>
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<td>Uganda</td>
<td>Equipment Diagnostics &amp; epidemiology</td>
<td>Surveys Tests &amp; vaccines</td>
<td>Communication One Health Forum</td>
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<td>Tanzania</td>
<td>Diagnostics &amp; epidemiology Socio-economics</td>
<td>Survey Impact and drivers</td>
<td>Sharing information One Health collaborations</td>
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<td>West Africa</td>
<td>Epidemiology Diagnostics</td>
<td>Surveys Economic data</td>
<td>One Health Strategy Communication</td>
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<tr>
<td>Nigeria</td>
<td>Laboratory Diagnostics</td>
<td>Surveys Economic &amp; health</td>
<td>Brucella working group Communication</td>
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<tr>
<td>Egypt &amp; Somalia</td>
<td>Laboratory Control</td>
<td>Surveys Health impacts</td>
<td>Vet networks Communication</td>
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The presentation of priorities was followed by discussion. Some of the points raised included:

- The important role of international organizations in harmonizing legislation according to national priorities
- Brucellosis is a transboundary disease and requires a regional approach
- We still lack information on situation of brucellosis in each country
- There is need to develop communication and network between countries
- There is a lack of cooperation between Francophone and Anglophone countries and brucellosis can be an opportunity for improving collaboration
- Coordination and knowledge sharing is required at a higher level. In the example of typhoid, also a neglected disease, collaboration led to better management.
- There is a lot of information which is neither published nor shared.
- A network to share information would be helpful
- There is a need to harmonize trade regulations, movement permissions and control. There are many different regulations which impede trade.
The way forward: What are we going to do following the meeting?

In the next part of the session, the facilitator asked groups by African region what they would do as the way forward.

**East Africa**
"We will convene into groups using administrative heads to meet and develop the details on the basis of which funding can be obtained and control started. We will take forward the findings and recommendations of the meeting. We will inform decision-makers on the importance of this disease and try and bring the stakeholders together. The next time we meet we will come with progress reports."

**South Africa**
"Compared to some other countries, brucellosis is relatively under control but the meeting has highlighted some possible gaps. We have taken notes and will take these forward."

**North Africa**
"We will contact colleagues in veterinary services to share the information we have received. We will try and start up a preliminary study for one or two states."

**West Africa**
"There is much to do on this disease. We will transfer the information we have learned and try and maintain a relation between the West African countries for working together on brucellosis."

**Final sum up from the Chair**
"Thank you for convening this very important brucellosis meeting. It has exceeded my expectations in the level of information sharing. My take home message: RB 51 and S19 are tools that can help for diagnostics and control. I came with many questions and I go home with more confidence in applying diagnostics and control. A second point is that for control, we are at different levels. I was re-assured that targeting high prevalence levels can help control. We have a challenge: the need for a platform for sharing information and we need to think how we can use the networks we have. If USDA has succeeded in bringing us here, we can do the same for the future. We need a toolkit for economic assessment for zoonotic diseases to go alongside the epidemiological tools. Finally, we thank USDA, ILRI and USAID for this meeting."

In conclusion, Eileen Herrera thanked the organizing committee (Eileen, Irlene, Joyce and Delia) and the ILRI staff who facilitated the meeting (Hailu, Rahel, Getachew and Isaiah).
Overall summary of the workshop

Gaps
- Lack of good, inexpensive, sensitive and specific diagnostic tests
- Questionable quality control of diagnostic test results due to poor reagents and inexperienced technicians
- Inability to type *Brucella* easily at the local level
- Lack of comprehensive regional surveillance programs
- Effective, safe, stable ‘Differentiating Infected from Vaccinated Animals’ (DIVA) vaccines

Needs
- Reliable, sound data to convince governments to recognize the need to develop strategies to control brucellosis
- Coordination of biosafety and laboratory training
- Funding for research and surveillance to better understand *Brucella* spp. in various domestic and wild animals in Africa
- More epidemiology for use in determining incidence and economic impact of the disease
- Cold chain storage for vaccines
- Education
- Establish baseline levels of disease within countries and regions

Challenges
- Impress upon governments that brucellosis needs to be addressed through surveillance and control strategies
- Provide adequate compensation to enable positive animals to be removed from the herds
- Education to reduce consumption of raw milk and dairy products, overcoming cultural practices
- Developing effective and affordable vaccine strategies at the regional level
- Lack of a DIVA vaccine

Way forward
- Continue to develop a network of researchers/animal authorities to collaborate with research which will provide hard data for government use
- One Health – utilizing community health and animal workers to educate and help develop control strategies
- Work with governments and non-governmental organizations to coordinate surveillance and studies – avoid repetition and maximize the funds available
- Network with countries, regions and/or governments that have developed successful strategies
## Appendix 1: List of participants

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<th>Name</th>
<th>Institution</th>
<th>Title</th>
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<tbody>
<tr>
<td>1</td>
<td>Abdelkhalik Montasser</td>
<td>AU-IBAR</td>
<td>Regional coordinator of VET-GOV program</td>
<td>Kenya</td>
</tr>
<tr>
<td>2</td>
<td>Abdisalam Warsane Mohamed</td>
<td>Puntland Veterinary Board</td>
<td>Chairman</td>
<td>Somalia</td>
</tr>
<tr>
<td>3</td>
<td>Abdu Hayghaimo</td>
<td>Ministry of Livestock and Fisheries Development</td>
<td>Assistant director for veterinary public health, livestock products and inputs control</td>
<td>Tanzania</td>
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<td>Abdulkadir Usman Junaidu</td>
<td>Usmanu Danfodiyo, Department of Veterinary Public Health &amp; Preventive Medicine</td>
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<td>Alehegne Yirsaw</td>
<td>Ministry of Agriculture, National Animal Health Diagnostic and Investigation Center</td>
<td>Associate researcher, bacteriology lab head, deputy quality manager, coordinator of student externship MSC and PhD</td>
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<td>Amahyel Madu Gusi</td>
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<td>Anani Adeniran Bankole</td>
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<td>Veterinary inspector/head of meat inspection section</td>
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<td>8</td>
<td>Andrew Clark</td>
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<td>Consulting veterinarian</td>
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<td>9</td>
<td>Bassirou Bonfoh</td>
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<td>Director general</td>
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<td>10</td>
<td>Bernard Erima</td>
<td>Makerere University Walter Reed Project</td>
<td>Lab manager, emerging and re-emerging infectious disease lab</td>
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<td>11</td>
<td>Charity Agada</td>
<td>University of Agriculture, Veterinary Department</td>
<td>Lecturer</td>
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<td>12</td>
<td>Charles Chris Rutebarika</td>
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<td>Assistant commissioner, disease control</td>
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<td>13</td>
<td>Charles Njuguna</td>
<td>World Health Organization (WHO) Integrated Disease Surveillance and Response</td>
<td>National professional officer</td>
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<td>Chrisostom Ayebazibwe</td>
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<td>15</td>
<td>Clet Wandui Masiga</td>
<td>Agrobiodiversity and Biotechnology Program, Association for Strengthening Agricultural Research in Eastern and Central Africa</td>
<td>Conservation biologist and geneticist</td>
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<td>16</td>
<td>Daniel P Mdeetele</td>
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<td>17</td>
<td>David Ojigo</td>
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<td>18</td>
<td>Delia Grace</td>
<td>ILRI</td>
<td>Program leader, Food Safety and Zoonoses and theme leader, Agriculture Associated Diseases, CGIAR Research Program on Agriculture for Nutrition and Health</td>
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<td>John Kaneene</td>
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<td>Kariuki Njenga</td>
<td>Virologist and Head</td>
<td>Integrated Human-Animal Health Program, Global</td>
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<td>41</td>
<td>Mbaye, Mbengue</td>
<td>Scientist in Microbiology</td>
<td>Institut Sénégalais de Recherches Agricoles,</td>
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<td>42</td>
<td>Mohamed Amar</td>
<td>Head of department of Epidemiology</td>
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<td>43</td>
<td>Obed Malangu Nyasebwa</td>
<td>Officer in Charge</td>
<td>Veterinary Investigation Centre</td>
<td>Tanzania</td>
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An integrated approach to controlling brucellosis in Africa: Workshop report
### An integrated approach to controlling brucellosis in Africa: Workshop report

<table>
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<tr>
<th>No.</th>
<th>Name</th>
<th>Institution/Position/Current Location</th>
<th>Position, Area of Expertise</th>
<th>Country</th>
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<tr>
<td>44</td>
<td>Peninah Munyu</td>
<td>Centers for Disease Control (CDC) Kenya</td>
<td>Epidemiologist</td>
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<td>45</td>
<td>Peter Mbatha</td>
<td>Central Veterinary Lab</td>
<td>Senior assistant director of veterinary services</td>
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<td>46</td>
<td>Qwari Bura</td>
<td>Tanzania Veterinary Lab Agency</td>
<td>Zonal lab manager/veterinary officer</td>
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<td>47</td>
<td>Rees Murithi Mbaabu</td>
<td>Ministry of Livestock Development, Department of Veterinary Services</td>
<td>Head, veterinary epidemiology &amp; economics unit</td>
<td>Kenya</td>
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<td>48</td>
<td>Reuben Ocholi</td>
<td>National Veterinary Research Institute, Vom</td>
<td>Director, Quality Assurance</td>
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<td>49</td>
<td>Roger Pellé</td>
<td>ILRI</td>
<td>Molecular biologist and scientist, vaccines and diagnostics</td>
<td>Kenya</td>
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<td>Ronald Bameka</td>
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<td>Rosekellen Njiru</td>
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<td>Samuel Arimi</td>
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<td>Sanogo Moussa</td>
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<td>Manager, Bacteriology Unit</td>
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<td>Shamsudeen Fagbo</td>
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<td>55</td>
<td>Stella Kiambi</td>
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<td>Stephen Gathogo</td>
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<td>57</td>
<td>Steve Hennager</td>
<td>USDA-ARS</td>
<td>Microbiologist and team leader, Serology Section</td>
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<td>58</td>
<td>Steve Olsen</td>
<td>USDA-ARS</td>
<td>Veterinary medical officer, Infectious Bacterial Diseases Research Unit</td>
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<td>59</td>
<td>Sylvia Baluka Angubua</td>
<td>Makerere University, Department of Biosecurity &amp; Veterinary Public Health</td>
<td>Assistant lecturer</td>
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<td>Sylvia Omulo</td>
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<td>61</td>
<td>Tariku Jibat Beyene</td>
<td>Addis Ababa University, Faculty of Veterinary Medicine</td>
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<td>Tim Rowan</td>
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<td>Ulf Magnusson</td>
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<td>Waleed Saad El-din El-Wahab</td>
<td>Central Lab for Evaluation of Veterinary Biologics</td>
<td>Senior researcher</td>
<td>Egypt</td>
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<td>William de Glanville</td>
<td>University of Edinburgh/ILRI</td>
<td>PhD student/graduate fellow</td>
<td>Kenya</td>
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<td>William Mwebembezi</td>
<td>Mbarara Regional Veterinary Laboratory</td>
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<td>Wilson Bertu</td>
<td>National Veterinary Research Institute</td>
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<td>69</td>
<td>Wondu Kelbessa</td>
<td>Addis Ababa University</td>
<td>Lecturer and head of department, animal sciences</td>
<td>Ethiopia</td>
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## Appendix 2: Workshop agenda

<table>
<thead>
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<th>Tuesday 29 January 2013</th>
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<tbody>
<tr>
<td><strong>07:00-08:00</strong></td>
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<tr>
<td>Registration and sign up for breakout sessions</td>
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<tr>
<td><strong>08:00-08:30</strong></td>
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<tr>
<td><strong>Opening session</strong></td>
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<tr>
<td>Welcome</td>
</tr>
<tr>
<td><em>Eileen Thacker</em>, USDA-ARS</td>
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<tr>
<td><em>Azage Tegegne</em>, CGIAR and ILRI</td>
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<tr>
<td><em>Abdelkhalik Montasser</em>, AU-IBAR</td>
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<tr>
<td><em>Eileen Herrera</em>, USDA-ARS</td>
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<tr>
<td><em>John Graham</em>, USAID</td>
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<td><strong>08:30-08:50</strong></td>
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<tr>
<td><strong>Presentation</strong></td>
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<tr>
<td>Brucellosis: The bugs and the disease</td>
</tr>
<tr>
<td><em>Eileen Thacker</em>, USDA-ARS, USA</td>
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<td><strong>08:50-09:10</strong></td>
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<tr>
<td><strong>Presentation</strong></td>
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<tr>
<td>Differential diagnosis of brucellosis serological reactions</td>
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<tr>
<td><em>Steve Hennagèr</em>, USDA-APHIS, USA</td>
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<td><strong>09:10-09:30</strong></td>
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<tr>
<td>Epidemiology of brucellosis in ruminants: The basics and dynamics of the disease</td>
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<tr>
<td><em>John Kaneene</em>, Michigan State University, USA</td>
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<td><strong>09:30-09:50</strong></td>
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<td><strong>Presentation</strong></td>
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<tr>
<td>Risk assessment for <em>Brucella</em></td>
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<td><em>Anani Adéniran Bankolé</em>, Direction of Livestock Services, Togo</td>
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<td><strong>09:50-10:15</strong></td>
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<td><strong>Break</strong></td>
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<td><strong>10:15-10:40</strong></td>
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<tr>
<td>Beneficial approaches for controlling brucellosis</td>
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<tr>
<td><em>Steve Olsen</em>, USDA-ARS, USA</td>
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<td><strong>10:40-11:00</strong></td>
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<tr>
<td>Economics of <em>Brucella</em> control</td>
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<tr>
<td><em>Bassirou Bonfoh</em>, CSRS, Côte d’Ivoire</td>
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<td><strong>11:00-11:20</strong></td>
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<td><strong>Presentation</strong></td>
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<tr>
<td>Laboratory biosafety and biosecurity issues related to <em>Brucella</em> research and diagnostics</td>
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<tr>
<td><em>Joseph Kozlovac</em>, USDA-ARS, USA</td>
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<td><strong>11:20-11:40</strong></td>
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<tr>
<td>One Health Units and brucellosis in Kenya</td>
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<tr>
<td><em>Stella Kiambi</em>, Ministry of Livestock Development, Zoonotic Disease Unit, Kenya</td>
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<td><strong>11:40-12:00</strong></td>
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<tr>
<td>Overview of brucellosis in the Middle East and AU-IBAR projects</td>
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<tr>
<td><em>Abdelkhalik Montesser</em>, AU-IBAR</td>
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<td><strong>12:00:12:20</strong></td>
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<td><strong>Conclusions and overview of makeup of workshop</strong></td>
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<td><em>Delia Grace</em>, ILRI, Kenya</td>
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<td><strong>12:20-13:30</strong></td>
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<tr>
<td><strong>Lunch</strong></td>
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<td><strong>Breakout sessions</strong></td>
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<tr>
<td>- Diagnostics – Serological Screening Tests (Room 14)</td>
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<td>- Biosafety (Room 13)</td>
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<tr>
<td>- Epidemiology – Large Ruminants (Auditorium 1)</td>
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<tr>
<td>- Vaccination and Control – Small Ruminants (Auditorium 2)</td>
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<td><strong>15:30-16:00</strong></td>
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<td><strong>Break</strong></td>
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<td><strong>16:00-18:00</strong></td>
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<td>- Diagnostics – Confirmatory Tests (Room 14)</td>
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<td>- Epidemiology – Small Ruminants (Auditorium 1)</td>
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<td>- Vaccination and Control – Large Ruminants (Auditorium 2)</td>
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## Wednesday 30 January 2013

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<td>Overview of ARS brucellosis research</td>
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<td><em>John Kaneene, Michigan State University, USA</em></td>
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<td>08:45-09:00</td>
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<td>Studies on zoonoses in western Kenya</td>
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<td>Surprising results from investigations in brucellosis prevalence</td>
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<td><em>Eric Fèvre, ILRI, University of Edinburgh</em></td>
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<td><em>William de Glanville, ILRI, University of Edinburgh</em></td>
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<td>09:00-09:15</td>
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<td>Risk factors for <em>Brucella</em> seropositivity in cattle, goats and humans in Mbarara</td>
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<td><em>Edward Ssekawojwa, Lvantonde District Local Government, Uganda</em></td>
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<td>09:15-09:30</td>
<td><strong>Presentation</strong></td>
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<td>Bovine brucellosis</td>
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<td><em>Tujuba Jergefa Oncho, Addis Ababa University, Ethiopia</em></td>
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<td>09:30-09:45</td>
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<td>The prevalence of antibodies against <em>Brucella</em> among breeding goats in relation to source</td>
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<td><em>William Mwebembezi, Mbarara Regional Veterinary Laboratory, Uganda</em></td>
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<td>09:45-10:30</td>
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<td>Epidemiology – Large Ruminants (Auditorium 1)</td>
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<td>Vaccination and Control – Small Ruminants (Auditorium 2)</td>
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<td>Biosafety (Room 13)</td>
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<td>16:00-18:00</td>
<td><strong>Open Q&amp;A for speakers</strong></td>
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<td>18:30-19:30</td>
<td><strong>Reception and poster viewing</strong></td>
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## Thursday 31 January 2013

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<td>08:00-10:00</td>
<td><strong>Breakout sessions report on information</strong></td>
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<td>10:30-12:00</td>
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<td>12:00-13:00</td>
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<td><strong>Conclusions and the way forward</strong></td>
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Appendix 3: Reports of the breakout sessions

Appendix 3.1: Biosafety Breakout Sessions

Joseph Kozlovac
Agency Biosafety Officer, USDA ARS

Introduction
Brucellosis is the most common laboratory acquired disease so biosafety is of critical importance. In addition, *Brucella* species have the potential to be used as a biological weapon making laboratory security critical. A general overview was provided on the morning of the first day of the workshop. As part of the workshop, two breakout sessions focused on biosafety and laboratory security issues were held. Both sessions were co-chaired by Roger Pellé, ILRI Kenya and Joseph Kozlovac, USDA ARS. Each group was asked to: (1) identify gaps, problems and successes; (2) map initiatives; (3) identify key research questions; and (4) identify other major observations. The two breakout sessions had very robust discussions and while various positive activities had been reported by participants in relation to biosafety and laboratory biosecurity, participants from both breakout sessions identified similar challenges and gaps related to general biosafety and biosecurity issues as well as those specifically related to work with the causative agents of brucellosis.

Key points
- Information on current international biocontainment practices for work with *Brucella*
- Current facilities and containment equipment for diagnostic and research laboratories
- Current practices and use of personal protective equipment
- Biosafety and laboratory security training needs
- Current national and institutional biorisk management practices and structures
- The major needs for improving biosafety or biorisk management practices in each country

Current facilities/containment and uses
- **Kenya/Kabete:** Biosafety Level (BSL)-2 lab, diagnostic work
- **KEMRI/CDC:** Handle rabies, flu, rickettsia, *Brucella*, BSL-3 and BSL-2 labs
- **Kenya/DVS:** BSL-3 lab, RVL, avian influenza (AI), brucellosis samples
- **Kenya/ZDU:** Public health units do no direct work in lab.
- **Kenya/WHO:** Serves as a focal point, no lab
- **Kenya/ILRI:** Has a BSL-2 lab. Human and animal biological samples. Routine diagnostic
- **Ethiopia/National Animal Health Diagnostic Lab:** BSL-2 and BSL-3 labs. The Food and Agricultural Organization constructed a BSL-3 lab. Interested in developing the ability to work on zoonotic diseases. East African reference laboratory for highly pathogenic avian influenza (HPAI) and Newcastle disease. Also bacterial serology lab on *Brucella*.
- **Egypt/Central Lab:** Vaccine development, diagnosis, *Brucella*, BSL-2. Working on construction of a BSL-3 lab.
• **Egypt/University of Cairo**: Teaching veterinary public health, culture and diagnostic lab.

• **Cote d’Ivoire**: Central Veterinary Laboratory (CVL). Diagnosis of bacterial diseases. Biosafety cabinets in labs. No lab classifications.

• **Tanzania**: Was CVL, now an agency (Veterinary Laboratory Agency) with 20 centres. Central lab and vaccine production. Brucellosis and tuberculosis diagnostics. Centre for Infectious Diseases and Biotechnology (BSL-3).

• **Uganda/Makerere University**: Makerere University Walter Reed Project – Emerging Infectious Diseases Laboratory, a BSL-2 laboratory with IsoArk, is situated within the College of Veterinary Medicine, Animal Resources and Biosecurity. It is involved in surveillance of emerging infectious diseases and antimicrobial resistance. It also provides support to microbiology laboratories in hospitals which are the sentinel sites for antimicrobial resistance surveillance in Uganda.


• **Nigeria/National Veterinary Research Institute**: Diagnostics, vaccine production, extension. Department of bacterial research for brucellosis, BSL-2. BSL-3 for avian influenza. A reference laboratory for avian influenza for West Africa.

• **Nigeria**: Research: no containment/standard wet lab

• **Ethiopia/Addis Ababa University**: Microbiology lab but does not meet international biosafety requirements.

**Key gaps**

**Laboratory equipment**

• Safety and laboratory equipment failure/part replacement/maintenance.

• One common issue identified by participants was that available funding for livestock and agricultural laboratories was extremely minimal in comparison to human health. In most countries where laboratories have containment equipment like class II biological safety cabinets, it is difficult to maintain and annually certify them in accordance with internationally recognized standards.

• A common identified problem related to equipment and facilities in general was power availability/disruptions. In addition to electrical grid availability, alternatives and the cost of installing, maintaining and fueling backup generators tends to be prohibitive in many cases.

**Way forward**

• Within countries or even on a regional basis, life science organizations should communicate various ideas and approaches.

• Coordinate and synchronize times among institutions and within countries or regions for maintenance solutions to reduce service vendor travel costs and scheduling conflicts.

• Evaluate the potential mechanisms to share certification costs such as utilizing collective bargaining (more than one institution) for contracting services with relevant vendors.
• Train and develop local capacity for maintenance and certification of laboratory equipment

• Train scientists to perform routine maintenance but not certify or repair equipment.

**Diagnostic and research waste management**

• Waste management capacity varied widely among countries and facilities for both solid and liquid biohazardous waste generated as part of diagnostic and research work.

• Solid biological/medical waste often needs to be transported to remote locations for treatment (typically incineration sometimes as far as 100 km away, according to Ugandan colleagues). In many countries, the government labs have capacity for solid biohazardous waste management but academic labs lack capacity. For example, in Ethiopia in the university setting, biohazardous waste is left for cleaners which causes an increased risk of occupational exposure to this category of staff who are not necessarily trained on risks and appropriate procedures. Based upon the discussion, many universities are doing research on brucellosis and other aerosol-transmitted diseases but have no facilities to adequately treat and dispose of infectious waste.

• Liquid waste is a particular problem. Untreated waste water ends up draining into main water bodies. Central liquid waste treatment for a facility is an expensive investment beyond most research and diagnostic facilities.

**Way forward**

• At the lab level, evaluate the ability to use available technology for point of use decontamination (for example, under sink continual flow systems). Labs can consider collecting liquids and autoclave or chemically treat this type of waste prior to disposal into a sewage system. There are some existing systems that exist that can treat this type of waste flow that are fairly cost effective.

• **Kenya**: Has developed legislation on biosafety which governs how waste is disposed. Typically use a coloured bin approach to segregate wastes. Each district hospital is equipped with an incinerator for solid biomedical/medical waste.

• **Nigeria**: Has a standard means of containing waste and transporting to an incinerator. There is a well-established process for handling waste and the individuals who handle waste are trained.

• Potential to utilize regional biosafety associations to raise awareness and conduct training on biohazard waste disposal issues.

**Transportation of samples (cost, training, issues with ground transport)**

• Availability and cost of shipping materials is an issue as well as ensuring everyone involved in the transport is adequately trained. Maintaining chain of custody and cold chain of samples (impacts quality of samples and tissues received) is an ongoing challenge especially as it relates to ground transportation (which utilizes public transportation in some cases). Triple packaging is not utilized in many countries.

**Way forward**

• Evaluate the potential to ship samples via designated vehicles in villages. These could be operated by trained drivers/carriers on designated routes to transport samples to the laboratories.
• **Tanzania**: Capacity of labs is challenged. Two vets and two technicians in a zone (52 districts). At district level, there are veterinary centres. The zonal lab provides packaging services for samples.

• Partner with other laboratories and via biosafety associations for provision of training and support for sample transportation issues.

**Coordination of biosafety training/knowledge**

• Need to identify core competencies needed for individuals working with *Brucella* species and identify what level of training is needed for each level from technicians to senior leadership.

• Level of legislation/regulation/standards varies a great deal between countries and regions as does the political will to address biosafety issues related to *Brucella* work.

• Access to appropriate personal protective equipment and the training to use it properly is needed.

• There is a need to change biosafety culture within African institutions; in many cases accidents and illnesses not reported due to concerns about negative repercussions.

• **Ethiopia**: University PhD student. Universities need training, infrastructure needed.

**Way forward**

• Establish biosafety associations in countries or encourage institutions to join the existing African Biosafety Association. These groups can serve as focal points to share information as well as educate and influence national and regional bodies with the goal of establishing national and regional policy infrastructures.

• Develop competency standards for individuals working at various containment levels for biosafety.

• Partner to train the trainers (internal and external)

• Set up a biosafety training program for Africa: One suggested course of action was to present the issue to the Biosciences eastern and central Africa (BecA) hub at ILRI to create a biosafety training/forum as a new initiative. There was some robust discussion as to whether the BecA hub was the best fit for this initiative. Some of the participants expressed that a forum minimally at the level of East Africa was a positive idea and should allow discussion between neighbouring countries regarding biosafety activities.
Appendix 3.2: Epidemiology breakout sessions

John B. Kaneene
University Distinguished Professor of Epidemiology & Director of the Center for Comparative Epidemiology

Introduction
In the plenary sessions, there was a general overview on brucellosis presented by a number of experts. The areas covered included: epidemiology, diagnostic tests, disease control, and bio-safety. To follow up at an individual country level within topics, small breakout sessions were created covering four topics and assigned specific questions to address to ascertain gaps and needs. The epidemiology breakout sessions were divided into two major areas—large ruminants and small ruminants. Within the large and small ruminant sessions, the groups were assigned to discuss the following areas: key areas of concern and need, current initiatives on brucellosis in the different countries, gaps and research needs, main challenges, suggestions for a way forward, and success stories.

Epidemiology of brucellosis in large ruminants

Key points
- Brucellosis is reportable in most countries but surveillance systems are weak
- Distinguishing between the ‘problem’ and ‘reality’ is critical. As an example, we should not treat pastoralism as a problem but a reality and work to solve problems in that context
- Aiming at a system where individually infected animals can be traced to their origin may not be affordable at this time and is not essential for making progress in disease control.

Current initiatives on brucellosis
- **Kenya**: A study on milk-borne zoonoses with the Department of Veterinary Services and the Kenya Agricultural Research Institute covering four districts.
- **Kenya**: ZDU and CDC cross-sectional and longitudinal study on brucellosis in four key districts.
- **Uganda**: National agriculture development on goats, including brucellosis control.
- **Uganda**: Studies of brucellosis in cattle, goats, and humans in western areas.
- **South Africa**: A brucellosis program has been developed which includes a manual for vaccinators. The government currently provides the vaccine.
- **Egypt**: Test and slaughter programs are currently being conducted.
- **Nigeria**: Active surveillance programs are being conducted by the National Veterinary Research Institute.
- **Nigeria**: A project supported by the European Union that is investigating zoonotic diseases includes brucellosis.
- **Ethiopia**: Creation of a meat and milk safety unit which will investigate brucellosis.

Key gaps and research needs
A number of gaps were identified by the different participating countries. In general, the gaps and research needs were very similar across all the countries. The following are representative of the gaps and research needs identified in selected countries:
- **Ethiopia**: Funding to develop comprehensive surveillance and more uniform research
- **Ivory coast**: Surveys to understand prevalence and impact (cross-sectional and abattoir)
- **Nigeria**: Need increased animal and human data and to develop a control program
- **Egypt**: Develop a national identification and traceability system for animals
- **Tanzania**: Develop traceability and active surveillance programs
An integrated approach to controlling brucellosis in Africa: Workshop report

- **Uganda**: Determine the economic costs of disease in humans and animals and perform risk analysis on risks from disease; legislation to make brucellosis reportable; concrete data on human/animal disease
- **Côte d’Ivoire**: Concrete data on the disease in humans and animals using a One Health approach
- **Kenya**: Sensitization and awareness creation; active surveillance and information on prevalence across the entire country and then establish strategy; coordinated database
- **Togo**: Need active surveillance

**Main challenges**
- Inadequate funding for compensation if animals are destroyed
- Cultural habits of consuming raw milk
- Vaccines not affordable to farmers and cold chain is difficult
- Wildlife interface in some countries
- Movement of people and animals difficult to restrict
- Lack of adequate surveillance that concretely identifies severity of disease

**Suggestions for way forward**
- Target only high prevalence areas initially
- Community animal health workers
- Evidence on cost and benefit of control options as well as the cost of the disease
- Re-establish prevalence of disease and determine socio-economic and public health impacts

**Key priorities**
- Establish baseline prevalence of disease
- Determine economic burden of disease in animals and humans
- Demonstrate the benefit of the control of brucellosis to the farmers.
- Promote brucellosis as one of the best models for One Health problems

**Success stories**
- **Kenya**: Formation of ZDU and the resulting collaboration between medical doctors and veterinarians
- **South Africa**: Sufficient allocation for disease control; standardized manual
- **Egypt**: Local vaccine production for one year
- **Nigeria**: Many surveys in the north of the country have shown prevalence of disease is increasing; vaccine is being produced; predominant infecting species identified (*B. abortus* biotype 1)
- **Ethiopia**: The Meat and Milk Institute and Safety laboratories have been established to try to use university research to answer problems

**Epidemiology of brucellosis in small ruminants**

**Key points**
- Small ruminants are often neglected
- Brucellosis in goats is probably an important source of disease across East Africa
- Need to involve economists, sociologists and gender specialists in evaluating economics and feasibility of control
- A farmer-supported control scheme for brucellosis in small ruminants may not be viable and require subsidization based on public health concerns
The problem of brucellosis in small and large ruminants and wildlife is intimately connected and needs to be evaluated in an integrated way.

There is a need for a safe, cheap and effective vaccine that does not need a cold chain storage.

We need to create awareness of the disease first, then talk about control next.

Surveillance and control based on prior data from multiple diseases may be the best way to develop plans to control this disease.

Current status

In most countries of Africa, there are more goats than sheep and goat meat is very popular. The husbandry can be viewed in two ways. One where goats are kept separate and the other where they are mixed with cattle and/or sheep, depending on the availability of land. Therefore, disease control strategies need to consider these differences of husbandry.

In many countries, women own most of the goats.

Goats are mainly used for meat, money or festivals; a niche market for goat milk is developing.

Key gaps and research needs

Brucellosis in small ruminants is not recognized by many as a significant disease so need studies to determine status.

Prevalence of brucellosis in goats needs to be established as well as the risk to human health.

Confirmation of field observations suggesting that brucellosis spills over from intensive farms to surrounding small ruminants.

Role of dogs and wildlife in the transmission of the disease needs to be established.

The lack of diagnostic ability to type brucellosis agent makes accurate diagnosis and control difficult.

Suggestions for way forward

Need more epidemiology but needs to be incorporated into a strategy.

Need a better understanding of transmission and health risks.

Need to have greater rationale for control – human health, poverty, gender, export.

USAID has a program to harmonize regulatory systems for a number of diseases.

AU-IBAR is working at the regional level due to the importance of brucellosis to trade.

Disease is not well known in communities, therefore there is need to raise awareness about the disease first, then design control strategies.

Determine socio-economic impact of the disease so that policymakers can appreciate the disease.

Overall summary remarks

1. There is a great need to determine the prevalence of brucellosis in both large and small ruminants.
2. Participants stressed that data on the economic and public health impacts of brucellosis are urgently needed.
3. Current surveillance systems in both animal and human populations regarding brucellosis are weak to non-existent in most African countries.
4. Awareness of the economic and public health consequences of brucellosis need to be implemented.
5. Affordable but reliable diagnostic tests need to be available so that scientists can adequately diagnose the disease in large and small ruminants, as well as humans.
Appendix 3.3: Brucellosis vaccination and control breakout sessions

Steven Olsen
National Animal Disease Center, USDA-ARS, Ames, IA

Introduction
Brucellosis remains a significant problem in Africa. In the workshop, the control and vaccination program discussions were divided into large and small ruminants due to differing production and management systems and vaccines and strategies for their use. Due to climate changes, economic factors and lifestyle, small ruminants are extremely common in Africa and are often raised in a pastoral management style. This allows close contact between animals and their human owners. In small ruminants, Brucella melitensis is the most common species isolated. To further compound its importance, it is also the most pathogenic to humans.

Vaccination for B. melitensis through the use of Rev1 can be problematic as it is poorly attenuated; the bacteria will concentrate in the mammary gland following vaccination, making these animals a public health risk for a period of time. The Rev1 vaccine will cause clinical brucellosis in humans and abortions in pregnant animals. In contrast, the B. abortus strain 19 vaccine can cause clinical disease in animals and humans but is considered to be less pathogenic than Rev1. It is critical to consider the public health consequences when vaccinating any female lactating animals against Brucella species. The United States switched vaccine use from Strain 19 to RB 51 as it can be used to differentiate vaccinated from infected animals. Vaccination strategies vary from country to country, but overall it is best to vaccinate young animals and avoid vaccinating either pregnant or lactating animals.

AU-IBAR is attempting to harmonize disease control for a number of transboundary diseases for export purposes. This is an attempt to strengthen the negotiations with the Arab peninsula. B. melitensis is one of the diseases on the list involved in this harmonization attempt. Information on prevalence in animals and humans is needed to support this initiative.

While the topic of the breakout session was control and vaccination, epidemiology and serology were also discussed due to the integrated nature of this topic. In addition, human Brucella remained a constant sidebar to the discussions. Vaccination and control strategies are major challenges and many gaps and challenges were identified. However, a few potential paths forward were also identified.

Vaccination and control strategies for small ruminants

Key points
- Need to characterize infections at the herd level
- Enhance herd immunity in endemically infected areas through vaccination
- Need enough data on incidence to convince policymakers to make brucellosis a priority disease to address and control; currently this is just one disease of many
- Need a regional approach particularly due to pastoralist livestock movement
- Since likelihood of vaccine programs is low, need to improve surveillance, education and outreach

Current initiatives
- Development of zoonotic disease units by CDC to improve interaction between public health and veterinary services in some countries; also a challenge in others
- Somalia conveys information to animal health workers to educate pastoralists
- Nigeria provides information to control transmission (see success stories)
- AU-IBAR initiative to harmonize control strategies for export purposes
Key gaps and research needs

- Education of people on public health concerns associated with brucellosis
- Knowledge of which *Brucella* species is infecting domestic livestock in various countries/areas
- Effectiveness of vaccine efficacy in different species (e.g. camels) is poorly characterized or documented
- Little to no knowledge of duration of immunity of current vaccines
- Appropriate age to vaccinate
- Epidemiology of surveillance for accurate disease documentation – both humans and animals
- Speciation and documentation of *Brucella* in small ruminants
- Control strategies for areas with low incidence
- What is the role of wildlife
- Possible antibiotic therapy
- Lack of reliable specific and sensitive diagnostic tests
- Standardization of human brucellosis case definition
- Standardization and consensus of government agencies on the importance of brucellosis

Main challenges

- In many countries (Somalia), need to reach out to pastoral people
- Quarantine is needed in many countries (Tanzania)
- If animals are vaccinated in negative areas, disease and titres may occur in those areas causing diagnostic and control problems
- Harmonization of diagnostic tests and procedures
- Need enough data to impress policymakers and need to communicate research results already collected
- Porous borders (Nigeria has five) so requires regional approach
- Lack of vaccine, cold chain issues and keeping vaccine cost affordable
- Poor interaction between veterinary services and public health
- Small agricultural budgets
- Politics
- Nigeria has a poor working relationship between veterinarians and public health officials. There is a lack of investigative centres, epidemiology and no trace-back capability.

Way forward

- Increase ZDUs or introduce in all countries
- Update legislation and regulations to cover brucellosis
- Develop national/regional strategic plans
- Hold regional meeting to target approaches that can be harmonized between countries
- Use community health workers to educate pastoralists – often the best way into a community
- Develop strategies to perform trace-backs on human cases to the infected animals
- Develop ongoing regulatory surveillance separate from research
- Increase standardization of diagnostics
- Identify the most vulnerable populations of animals and direct control towards them
- Identify appropriate vaccination strategies

Key priorities

- Awareness and outreach to high-risk communities
- Veterinary capacity
- Integrated regional approach with research, policy development, harmonization of diagnostics
- Developing new vaccines – combination products
- Accurate data on disease incidence in animals and humans
- Publication of research
Success stories

- Nigeria currently provides educational pamphlets, holds gatherings with tribal chiefs and herding associations to convey information and uses culture to educate
- Egypt vaccinated lambs with Rev1 by injection, followed by ocular administration and reduced disease occurrence by half
- Rift Valley fever (RVF) has provided a template for veterinarians and public health officials to work together closely. As a result, they worked closely together during a recent brucellosis outbreak
- First national conference on One Health held in Uganda
- In Uganda, veterinarians and public health officials have been working closely together since the HPAI outbreak. There is a veterinarian in the Ministry of Health. This has allowed close collaborations on RVF, anthrax and rabies outbreaks.

Vaccination and control strategies for large ruminants

Many of the gaps, challenges, initiatives and key points are identical between large and small ruminants.

Key points

- Similar to small ruminants, there is a need to characterize the *Brucella* sp. infections to differentiate infection with *B. abortus* and *B. melitensis*
- Need to pursue regional approaches to control
- Determine prevalence to ascertain the exact vaccination strategy to pursue
- No current guidelines for vaccinating camels for either species of *Brucella*.

Current initiatives

- South Africa currently requires cattle to be vaccinated as calves; vaccination of older animals is illegal. They use both RB 51 and Strain 19 vaccines. Only cattle are vaccinated and they have a test and cull program. Positive animals are branded, although they often disappear.
- Egypt previously vaccinated 500,000 in the Delta area. However, since the political revolution, maintaining the program has become problematic. The government purchases the vaccines and also practices test and slaughter programs.
- Tanzania has control programs in government herds (test and slaughter)
- Some initiatives in Uganda used students to conduct research surveillance but were short-lived.

Key gaps and research needs

- Need to establish government regulated surveillance programs
- Regionalization/harmonization of policies
- Determine prevalence in large ruminants using appropriate epidemiologic surveys
- Standardize diagnostic assays
- Establish vaccine strategies that will be effective for nomadic and adult animals

Main challenges

- Most countries lack formal surveillance programs
- Significant numbers of herds belong to nomadic peoples so difficult to regulate

Suggestions for way forward

- Establish effective movement control between countries – a regional approach
- Determine the actual prevalence in animals and humans within the country and use this to establish regulations and policies
Key priorities

- Brucellosis in large ruminants needs to be addressed
- Epidemiology
- Vaccine and control strategies established
- Regulations and policies developed
Appendix 3.4: Brucellosis diagnostic tests - Screening and confirmatory

Steven Hennager
Team Leader, Serology Section, Diagnostic Bacteriology
National Veterinary Services Laboratory, APHIS, Ames, IA

Introduction
An overview presentation was made in plenary on diagnostic assays for brucellosis. Diagnosis of the infection is a challenge in both humans and animals. There are a number of different types of diagnostic tests with different sensitivities and specificities. Most of the assays concentrate on detecting antibodies in fluids such as serum rather than isolating or detecting the organism. However, tests such as polymerase chain reaction (PCR) assays are increasing in availability and usefulness in detecting the organism. An advantage of tests that detect the organism is that they allow speciation of the organism for better interpretation and control strategies. In addition, there are differences in the ability to detect infection with the various Brucella species and, in the case of animals, species of animals. However, the lack of specificity – and thus cross-reactivity with other organisms – is problematic. Another major concern is the high risk of laboratory acquired infection for laboratory personnel involved in isolating or performing diagnostics for Brucella. All of these factors make the diagnosis of brucellosis in humans and animals challenging.

Key points
- In high incidence regions, serologic tests need sensitivity more than specificity. In low incidence regions, serologic tests need more specificity than sensitivity.
- All agglutination test reactions must be compared to the control sera reactions.
- No serologic test can determine if the antibody titre is due to vaccine or a Brucella species field strain infection.
- Serologic tests must be reliable and economical for use in a control program.

Current initiatives for diagnostics
- Many regional studies have been completed throughout Africa. It is difficult to interpret findings between animal and human brucellosis due to variation in study design and diagnostic assay.
  - Brucella melitensis, frequently associated with small ruminants, has been isolated from cattle.
  - Human treatment is difficult due to the frequent re-exposure to Brucella organisms.
  - A variety of confirmatory tests are available but only in a few laboratories.
  - Export animal centres are making decisions based on the results of screening tests without a highly specific confirmatory serologic test.

Key gaps and research needs
A significant number of gaps were identified that went across borders and were consistent with all of the African participants. The following are representative of those gaps and needs.
- A good, reliable and economic confirmatory test for livestock
• Serologic tests need to be validated in species other than bovine or porcine.
• Human testing needs a more specific test than the slide agglutination test.
• Can animal assays be used on human samples?
• Laboratory test results need to be combined with epidemiologic evidence before a positive brucellosis diagnosis can be made.
• How will a vaccination program affect the diagnostic tests used in diagnosis of the disease?
• For import and export testing with low incidence of brucellosis, what serologic tests can give a specific interpretation of the disease status of the animals tested?
• Develop case definitions and harmonization of test procedures, especially in areas where multiple diseases may complicate the diagnosis of brucellosis.
• Quality control for diagnostic labs and tests
• Camel and goat milk is homogenized so the ring test is not effective. An indirect enzyme-linked immunosorbent assay (ELISA) test is needed for accurate testing.
• Confirmatory tests must be more specific than screening tests. The fluorescent polarization assay is highly specific, simple, and portable. However, it does not appear to work as well with human testing and Brucella melitensis. Other confirmatory tests, such as competitive ELISA and complement fixation test, should be investigated.

Main challenges
• Lack of a good diagnostic test that can be used in all species of animals and humans
• Lack of quality control for diagnostic tests
• Reagents used for tests are often of poor quality and the technicians lack the skills to accurately perform the tests
• Many false positive serologic results occur for tests on humans, and few to no confirmatory testing is performed
• False positive results for animals in the export/import market from areas of low incidence of brucellosis.
• PCR works best with bacteraemia and is more useful in human cases
• Isolation of bacteria from serological positive animals is successful in only approximately 40% of the animals in the USA.
• Treatment of humans with antibiotics needs to be continued for a full eight weeks. Treatment may be compromised if the patient becomes re-infected during the course of treatment.

Suggestions for a way forward
• Investigate combining human and animal diagnostic laboratories in the One Health Initiative.
• Use the brucellosis 8% card for B. abortus and the 3% card for B. melitensis.
• Increase sampling of bulk tanks with milk ring test.
Key priorities

- Improve quality control of reagents and training of personnel for quality control
- For import/export controls, develop a testing standard operating practice to enhance test accuracy
- Work to develop reference laboratories for confirmatory screening
- Work with epidemiologists to design studies that will provide accurate and reliable data
- Develop an indirect ELISA test that can be used to accurately test camel and goat milk.
Appendix 4: List of presentations

All the presentations are available online on the workshop website, https://sites.google.com/cgxchange.org/brucellosis-africa and in the ILRI repository, http://cgspace.cgiar.org/handle/10568/32725. For ease of reference, the titles of the presentations listed below are linked to SlideShare.

**Workshop overview**

*Brucellosis: The bugs and the disease*: Eileen Thacker

*Differential diagnosis of brucellosis serological reactions*: Steve Hennager

*Epidemiology of brucellosis in ruminants: The basics and dynamics of the disease*: John Kaneene

*Risk assessment for *Brucella**: Anani Adéniran Bankolé

*Beneficial approaches for controlling brucellosis*: Steve Olsen

*Economics of *Brucella* control*: Bassirou Bonfoh

*Laboratory biosafety and biosecurity issues related to *Brucella* research and diagnostics*: Joseph Kozlovac

*One Health units and brucellosis in Kenya*: Stella Kiambi

*Brucellosis: Past, present and future in the Middle East and Africa*: Abdelkhalik Montasser

**Research plenary session**

*Overview of brucellosis research in the USDA Infectious Bacterial Diseases Unit*: Steve Olsen

*Overview of Michigan State University brucellosis research in Africa*: John Kaneene

*A framework for understanding zoonoses at the livestock-human interface in western Kenya*: Eric Fèvre

*The (short) story of brucellosis in western Kenya*: William de Glanville

*Risk factors for *Brucella* seropositivity in cattle, goats and humans in Mbarara*: Edward Ssekawojwa

*Epidemiological study of bovine brucellosis in Ethiopia*: Tujuba Jergefa Oncho

*The prevalence of antibodies against *Brucella* among breeding goats in relation to source: A case study in Mbarara District, South Western Uganda*: William Mwebembezi

**Vaccination and control breakout session points**

*Overview of large animal brucellosis control strategies*: Steve Olsen

*Overview of small animal brucellosis control strategies*: Steve Olsen