

Zoonoses Project 5

Collating examples of Institutions, Policies and Stakeholders involved in the Management of Zoonoses

A final report to the UK Government Department for International Development (DFID)

Submitted by

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Executive summary

Zoonoses remain a major and increasing problem globally due to increasing world human population with intensifying livestock production, and ongoing encroachment of people and domestic animals into formerly sheltered natural ecosystems and greater contact with wildlife. Successful control of many zoonoses in developed countries has led to some complacency and loss of societal memory about these diseases, their profound impacts, and past control difficulties. However, they remain serious though often neglected problems in many developing countries and pose risks of re-emerging elsewhere. Meanwhile, the risks of possible zoonotic pandemics have never been greater, due to exponential increases in speed and volume of movements of people and goods around the world, and disruption to ecosystems associated with human activity and climate change.

Traditional veterinary and medical technical interventions for zoonotic disease prevention and control cannot simply be transferred without major modification for different social, economic and ecological contexts. Wider approaches must consider the mix of policies, institutional frameworks and mechanisms for stakeholder and community involvement.

The UK Government Department for International Development (DFID) is implementing a new program, **Zoonoses and Emerging Livestock Systems (ZELS)** to help alleviate poverty by better managing the risks of zoonoses through approaches which address the public health, animal health, environmental and economic dimensions and impacts of disease, and with a focus on small holder farmers and their emerging livestock systems.¹¹

DFID commissioned the CSIRO Australian Animal Health Laboratory (AAHL) to undertake Zoonoses Project 5 *Collating examples of policies, institutions and stakeholders involved in managing the risks of zoonoses*, to assist researchers submitting proposals to DFID, and the reviewers of the proposals by developing a meta-database of information resources, supported by a report, which focus on key researchable issues in this topic. The project scope is strongly focused on small holder livestock production systems and poverty alleviation, while the geographic scope is mainly on South East Asia, South Asia and Sub Saharan Africa. The aim is to encourage researchers and reviewers to think broadly about the opportunities for research, and to point people to information resources in the database that might be useful.

The database and report focus more on generic systems rather than specific diseases, and on key institutions, policies and stakeholders, rather than technical knowledge which is more readily available to researchers and reviewers. The report analyses five cross-cutting themes - 1) *Health systems strengthening research*, 2) *Livestock value chains and zoonoses*, 3) *Ecosystems, natural resource management and livestock production systems and their relationship with zoonoses*, 4) *Sustainable management of endemic zoonoses*, and 5) *Management of zoonotic disease emergencies*. Further detail is provided in Annexes to the report including seven case studies 1) *Nipah*, 2) *Rift Valley Fever*, 3) *HPAI*, 4) *Brucellosis*, 5) *Hydatid disease*, 6) *Livestock Value Chains*, and 7) *Rabies*.

The key messages from the theme chapters are set out below.

¹¹ Emerging livestock systems are defined as small scale livestock systems appearing in developing countries in response to the rising demand for animal products such as meat and milk. This programme will also include wider impacts of the emerging livestock systems on the food supply chain from production to consumption.

1 Health systems strengthening research

- Health systems strengthening research in low income countries is limited and has many challenges. However there are important drivers for research to underpin investments in public health systems and animal health systems to better address the complex challenges of neglected zoonotic diseases (NZDs) and the risks of emerging infectious diseases (EIDs) in small livestock holder communities.
- Broader and more integrated EcoHealth and One Health approaches to health systems strengthening for zoonotic disease prevention and control are needed, which also consider social and ecological determinants of health. Suggested principles to guide research for health systems strengthening, and with regard to institutions, policies and stakeholders, include:
 1. Shift the research focus from being discipline and supply-driven to inter-disciplinary research which meets the identified needs of regional and rural communities and smallholders.
 2. Increase the level of engagement of communities and civil society organisations in disease prevention and control programs, including trade associations, processors and retailers whose decisions may influence how livestock systems develop.
 3. Integrate understanding of social, cultural, ecological and economic factors in disease prevention and control programs.
 4. Strengthen capacity for translating research into sustainable actions at the village/sub-national/country/regional level. This requires deep knowledge of institutional arrangements and key stakeholders, and associated barriers and opportunities for systems strengthening. A key consideration is whether there is a functioning research-development continuum.
 5. Strengthen capacity for socio-economic analysis, and complex system analysis and evaluation.

2 Research on livestock value chains and zoonoses

- Research on livestock value chains is increasingly being used to study the risks and impacts of animal and zoonotic diseases on livestock systems, and to develop more appropriate interventions which target areas of highest risk and highest return for disease control. Value chain approaches integrate social and economic analysis, epidemiology and risk management.
- This research should identify and address the way that institutions, policies and stakeholders can strengthen profitable value chains and improve disease control with an appropriate and targeted mix of market assurance programs, incentives/disincentives and adequate regulation. Programs and policies that impact on value chains need to be flexible, resilient and adaptable to changing market requirements, livestock production systems and emerging zoonotic disease risks.
- Obstacles to the use of value chain analysis in zoonosis-related research, such as lack of communication between economists and disease control specialists, need to be weighed against the benefits, which may include more targeted control of zoonotic diseases, more effective interventions which accommodate complexity, more stakeholder participation and less regulation throughout value chains, and increased likelihood and capability for translating research into improved practices.

3 Research on ecosystems, natural resource management and livestock systems, and zoonoses

- Zoonotic diseases are influenced by changes to ecosystems, resource management and livestock production systems. Knowledge of these interactions is important for guiding institutional, stakeholder and policy responses to zoonotic diseases in smallholder livestock systems.
- Interdisciplinary research, involving social scientists, economists, environmental scientists and other disciplines is needed to understand and address the complex interactions between land use, ecology, livestock management systems and emergence of zoonotic diseases.

- There is a need to build capacity in developing countries for interdisciplinary and multi-sectoral research. Associated challenges are to ensure research efforts are well coordinated and focussed in areas of priority importance to stakeholders for the sustainable development of smallholder livestock systems.
- Health, agriculture and environmental agencies will need to work together to address these issues.

4 Research on sustainable management of endemic zoonoses

- Many serious endemic zoonoses have been neglected in developing countries as their burden, particularly upon the rural poor, is often severely underestimated. Economic analyses e.g. cost benefit studies, are usually necessary to justify and secure commitment for the long term interventions needed to achieve sustainable control.
- Strategies for sustainable management of endemic zoonotic disease will vary according to the types of diseases, their epidemiology in different locations and their impacts on human, livestock, companion animal and wildlife populations. This in turn will require the engagement of different sets of institutions, policies and stakeholders, often over long periods of time.
- Translating international commitment to tackle previously neglected zoonoses into effective national programs requires careful systems and operational research. Policies need to suit particular economic, social, cultural and environmental conditions at the regional, national and sub-national levels.
- New technical innovations must be assessed as to whether they will deliver improvements. However, old or new technologies alone will not work without sustained political will, commitment and funding, and effective program delivery mechanisms, as well as institutional and community engagement and support for program design, implementation and evaluation.
- Improvements in broader infrastructure such as housing, water supply and sanitation, and / or changes in animal management and cultural practices, may be necessary to break disease transmission cycles, and broad multi-disciplinary research and stakeholder engagement may be needed to identify and optimise these interventions.
- Research is needed on effective capacity building among communities and professionals, as well as in government and non-government organizations. Capacity building can include knowledge and skills development, a supportive institutional framework, and the ability to access resources such as funds and transport.

5. Research on management of zoonotic disease emergencies

- Outbreaks of serious zoonotic disease, whether new, emerging or re-emerging, constitute emergencies and disasters for the communities and countries in which they occur and should be prepared for and managed accordingly; however this is not always immediately recognised.
- Zoonotic disease emergencies may occur due to:-
 - a. Emergence of new diseases with unknown but possibly severe epidemic potential;
 - b. Incursions of known zoonotic diseases into countries or districts which had been historically free or had previously eradicated the disease; or,
 - c. Epidemics of known endemic zoonotic diseases, due to either inadequate preventive or control measures, or unknown but rare ecological events.
- Drivers for research to strengthen national frameworks for emergency zoonoses preparedness include
 - Increasing risks of zoonotic disease emergence or re-emergence with increased human and livestock population and increased travel and trade; and

- Increased global commitment and availability of improved emergency preparedness and response frameworks, new technologies, innovative community engagement models and international funding sources to tackle both newly emerging and previously neglected zoonoses which otherwise can cause disastrous outbreaks.
- The policies, institutions and stakeholders engaged in preparedness for and response to zoonotic disease emergencies are critical to their effective management. These will determine the success or otherwise of management and control efforts at least as much as, if not more than, detailed technical understanding of the disease.
- International disaster management frameworks should be and are being applied at the national level in many countries. Effective and implementable national emergency preparedness plans are the key to managing emergency zoonotic disease risks.
- Operational and systems research into the adequacy of zoonotic emergency preparedness in different countries can facilitate investments which will increase their long term resilience in the face of future zoonotic threats.

1. BACKGROUND

Zoonoses remain a major and increasing problem globally due to increasing world human population with intensifying livestock production, and ongoing encroachment of people into formerly sheltered natural ecosystems and greater contact with wildlife. Successful control of many zoonoses in developed countries has led to some complacency and loss of societal memory about these diseases, their profound impacts, and past control difficulties. However, they remain serious though often neglected problems in many developing countries and pose risks of re-emerging elsewhere. They are particularly acute in regions of poverty and civil or military conflict, with overcrowding, poor hygiene, ignorance, and weak governance and institutional arrangements.

Meanwhile, the risks of possible zoonotic pandemics have never been greater, due to exponential increases in speed and volume of movements of people and goods around the world, and disruption to ecosystems from human activity and associated with climate change and variability. There may be great technical uncertainty, bureaucratic or community inertia in the early stages of many epidemics, and public unrest or panic as the actual or perceived scale of problems becomes apparent.

Even traditional veterinary and medical technical interventions cannot simply be transferred without major modification for different social, economic and ecological contexts, while integration of veterinary, medical and wildlife biological efforts into a “One Health” approach is difficult. Wider approaches must consider the mix of policies, institutional frameworks and mechanisms for stakeholder and community involvement, and how these factors interact to deliver better outcomes.

The UK Government Department for International Development (DFID) is implementing a new program, **Zoonoses and Emerging Livestock Systems (ZELS)**. The overarching **aim of the ZELS program** is poverty alleviation by better managing the risks of zoonoses through approaches which address the public health, environmental and economic dimensions and impacts of disease, and with a focus on small holder farmers and their emerging livestock systems.¹²

DFID commissioned the CSIRO Australian Animal Health Laboratory (AAHL) to undertake Zoonoses Project 5 *Collating examples of policies, institutions and stakeholders involved in managing the risks of zoonoses*. The **purpose of Zoonoses Project 5** is to assist researchers submitting proposals to DFID, and the reviewers of the proposals by developing a meta-database of information resources, supported by a report, to inform and stimulate thinking about researchable issues, priorities and impacts, and encourage and inspire fresh approaches to research into policy and institutional development, and stakeholder engagement, which will have positive impacts for the handling of zoonoses.

The project scope is strongly focused on small holder livestock production systems and poverty alleviation. The geographic scope is mainly on South East Asia, South Asia and Sub Saharan Africa.

¹² The project team notes the DFID definition of emerging livestock systems as ‘small scale livestock systems’ appearing in developing countries in response to the rising demand for livestock products such as meat and milk.

2. APPROACH AND METHODS

An **Expert Reference Group (ERG)** with expertise in zoonoses, veterinary and medical epidemiology, public health, rural sociology, economics, agriculture, governance and One Health processes, was formed under the auspices of CSIRO AAHL, and supported by a research assistant and database developer. They organized examples of policies, institutions and stakeholders involved in zoonoses management in **five cross cutting theme chapters**:- 1) *Health Systems strengthening*, 2) *Livestock value chains*, 3) *Ecosystems, natural resource management and livestock production systems*, 4) *Sustainable management of endemic zoonoses*, and 5) *Management of zoonotic disease emergencies*. These theme chapters provided a framework for the report, search methodology, and review of zoonoses-related peer reviewed and grey literature to create a meta-database.

Extra information is provided in Annexes to the theme chapters and in **seven case studies**:- 1) *Highly Pathogenic Avian Influenza*, 2) *Livestock Value Chains*, 3) *Rift Valley Fever*, 4) *Bovine brucellosis*, 5) *Hydatidosis*, 6) *Nipah virus*, and 7) *Rabies*.

The **meta-database** was developed to be simple, searchable and useful to end users looking for examples of research programs and policies aimed at zoonoses risks, prevention and control, and to highlight knowledge gaps and innovations rather than the full body of literature. This includes links to useful websites rather than detailed searches of these websites. Information on non-zoonotic infectious disease (animal / human) is included only where learnings are relevant to zoonotic disease management and address evidence gaps. Searchable categories were developed in respect of the project scope (Appendix 2:- a) *Country / region*, b) *disease / pathogen*, c) *livestock system*, d) *research approach*, e) *sector*, f) *scope*, and g) *cross cutting theme*) and 535 selected relevant resources were entered and coded according to these categories.

The **review of knowledge** targeted relevant peer reviewed and grey literature via:

1. Selected search terms - validated by preliminary Medline searches:-
 - Priority zoonoses with a livestock interface for developing countries selected via review of three key references.¹³¹⁴¹⁵
 - Geographical focus - developing countries with a focus on sub-Saharan Africa, South Asia, South East Asia, and the Pacific.
 - Livestock systems - with a focus on smallholders and poverty alleviation.
 - Interventions - examples of integrated and interdisciplinary programs, policies or interventions in response to zoonoses risks from social, economic, environmental and public health perspectives rather than narrow technical approaches.
 - Context - of programs, policies or interventions.
2. Literature database search – Medline (29 March 2003 - 29 March 2012), Web of Knowledge (12 April 1993 - 12 April 2012, and CABI abstracts (17 April 1993 - 17 April 2012) were searched for peer reviewed literature and conference presentations in English using validated search terms.

¹³ Mathers et al 2002.

¹⁴ Perry et al 2002.

¹⁵ Jones et al. 2011.

¹⁵ http://en.wikipedia.org/wiki/Cold_chain

¹⁵ <http://en.wikipedia.org/wiki/EcoHealth>

¹⁵ <http://en.wikipedia.org/wiki/ELISA>

¹⁵ <http://wwwnc.cdc.gov/eid/pages/background-goals.htm>

¹⁵ <http://www.undp.org/content/undp/en/home/mdgoverview.html>

¹⁵ http://en.wikipedia.org/wiki/Neglected_diseases

¹⁵ <http://www.iconzafrica.org/resources/tackling-neglected-zoonoses>

3. Reference listings and key authors- publications by key individuals providing major inputs into the field and from listings in key major / seminal reports were searched.
 4. Websites - of major global institutions and aid providers in the field (e.g. WHO, OIE, FAO, DFID, USAID, CIDA, ILRI, ICONZ) were searched for examples of relevant reports, policies, news items.
- Selection of references for the database – Abstracts of papers and conference presentations identified via Medline, Web of Knowledge and CABI abstracts were screened by the research assistant and two ERG members for relevance before entry in the database.

3. CROSS-CUTTING THEMES

3.1 HEALTH SYSTEMS STRENGTHENING

1 Key messages for health systems strengthening research

- Health systems strengthening research in low income countries is limited and has many challenges. However there are important drivers for research to underpin investments in public health systems and animal health systems to better address the complex challenges of neglected zoonotic diseases (NZDs) and the risks of emerging infectious diseases (EIDs) in small livestock holder communities.
- Broader and more integrated EcoHealth and One Health approaches to health systems strengthening for zoonotic disease prevention and control are needed, which also consider social and ecological determinants of health. Suggested principles to guide research for health systems strengthening, and with regard to institutions, policies and stakeholders, include:
 1. Shift the research focus from being discipline and supply-driven to inter-disciplinary research which meets the identified needs of regional and rural communities and smallholders.
 2. Increase the level of engagement of communities and civil society organisations in disease prevention and control programs.
 3. Integrate understanding of social, cultural, ecological and economic factors in disease prevention and control programs.
 4. Strengthen capacity for translating research into sustainable actions at the village/sub-national/country/regional level. This requires deep knowledge of institutional arrangements and key stakeholders, and associated barriers and opportunities for systems strengthening. A key consideration is whether there is a functioning research-development continuum.
 5. Strengthen capacity for socio-economic analysis, and complex system analysis and evaluation.

2 Discussion

Health systems can be defined as all organisations, institutions and resources devoted to producing actions whose primary intent is to improve health (WHO-2000).

Development programs commonly distinguish vertical (disease specific) programs from horizontal programs which address the sustainable development of health system functions. Programs can also be described as 'diagonal' where a disease focus is tied to broader capacity building objectives.

A brief summary is provided of international agreements and trends which support health systems strengthening (Box 1); the goals and scope of health systems strengthening with reference to public health systems, animal health systems and community engagement; and some examples of initiatives, tools and resources for health systems strengthening. Further examples are in the Annexes and case studies and the database.

A background discussion of research for systems strengthening is in Annex 1. It includes the following topics with reference to key institutions, stakeholders and policies; researchable issues; health systems strengthening; and poverty, zoonoses, and smallholder livestock systems:

1. Aims and key considerations for systems strengthening research
2. Systems thinking

3. Socio-ecological systems research and applications
4. Social and cultural factors and systems strengthening
5. Governance and resourcing for systems strengthening
6. 'One Health' movement and systems strengthening.

Drivers for health systems strengthening

The following examples of international agreements and trends (Box 1) highlight the need for more coordinated, integrated and interdisciplinary approaches to research for health systems strengthening to alleviate poverty in vulnerable populations, and including for small livestock holder communities.

Box 1 – International agreements and trends that impact on health systems strengthening

- **Millennium Development Goal (MDG) and Paris Declaration on Aid Effectiveness (2005).** A 2011 OECD survey monitoring the Paris Declaration identifies that while national development plans are progressing there is mixed progress to enable civil society activities and shift capacity development from being supply driven to meeting developing country needs.
- **International regulations, standards and policies.** The new International Health Regulations (2005) strengthen non-disease specific, risk-based approaches to managing public health responses to international spread of disease. OIE international standards adopt risk and systems-based approaches for zoonoses, and are used by World Trade Organisation members to regulate trade under the Agreement on the Application of Sanitary and Phytosanitary Measures. The United Nations International Strategy for Disaster Reduction and Hyogo Framework for Action 2005-2015 is driving strengthened cooperative arrangements to build 'disaster resilience' of nations and communities.
- **New global structures, scaling up of resources and alignment with national development plans.** Consistent with the Paris Declaration, development programs are increasingly country-led, priority driven and results / outcome oriented. New structures and partnership models are being implemented to improve coordination, integration, resource mobilisation and accountabilities, lower transaction costs, and to increase involvement of civil society and the private sector. Scaling up of resources is limited by the absorptive capacity of national systems, requiring reassessment of donor and recipient government policies, and shifts in investment towards systems strengthening.
- **Weak public health, animal health and natural resource management systems with severely constrained economic resources in most of the developing countries.** A challenge is to develop well coordinated systems which integrate government, civil society organisation (CSO), private and donor supported services, and with specific services targeted to smallholders.
- **Negative consequences of narrowly focussed or imbalanced investment.** Developing countries report their limited resources being directed away from national priorities for sustainable development, including for neglected zoonotic diseases, to implement donor priorities, e.g. for avian influenza control.
- **Moves towards whole of government approaches (WGA)** for emergency planning for pandemic influenza, and as part of a broader disaster management and security agenda. A challenge for WGA is to address the needs of vulnerable populations, including smallholders. Evaluations of WGA for influenza pandemic preparedness have been undertaken in Africa (Orty et al. 2008) and in Asia (Hanvoravongchai et al. 2010). The Towards a Safer World global initiative is extending the lessons learned for pandemic preparedness and WGA. Frameworks are being developed to extend WGA systems strengthening approaches to EIDs more broadly (Mounier-Jack et al. 2010).
- **Growing pressures on food security** associated with increasing world population, per capita income and urbanisation in emerging economies, trade, demand for safe food and for animal sourced protein, and unregulated intensification of livestock systems. These trends raise many challenges for managing zoonotic disease risks for which systems strengthening is required at a local to global level, and including for the delivery of veterinary and animal health services. The impacts of these trends on smallholder livestock systems and poverty alleviation are uncertain.

- **Risks of disease emergence and the need to better manage disease risks at their source.** High profile diseases like SARS, HPAI and HIV/AIDS have raised community and political awareness and concern about the potentially enormous social, health and economic consequences of disease emergence and the need to better manage disease risks at their source. Ecologists identify many developing countries as ‘hot spots’ of disease emergence and are calling for increased resources for early warning and surveillance to be directed to these areas (Jones, Patel and Levy 2008).

Public health systems

Public health goals and objectives for health systems strengthening are to improve one or more functions of the health system to improve access, equity, quality or efficiency. Functions typically refer to health system governance, financing, human and physical resources (with reference to information, medicines and technologies), and services.

Research on health systems strengthening in low income countries is limited, but is increasing. Challenges include inadequate understanding and clarity about what health systems strengthening involves, limited information and evidence about what works, and lack of evaluation of health sector reforms. Investment in expertise in donor organisations and recipient governments is required for more effective use of funds for systems strengthening (Balabanova et al. eds. 2011, p7).

The WHO is developing a Health Systems Research Strategy to be launched in November 2012. The Strategy seeks to address conceptual issues in health systems research, and lack of institutional and health system capacity for health systems research and its use.

Animal health systems

Animal health goals and objectives for health systems strengthening are generally described (e.g. by FAO and OIE) with regard to strengthening veterinary public health services and surveillance systems. Animal health systems support livestock value chains which are an important pathway for poverty alleviation for smallholder livestock systems (further details are in the following chapter).

International agencies (e.g. OIE, FAO, WHO and DFID) are collaborating to strengthen animal health systems and the linkages between the animal health and public health systems (WHO, 2005; Global Early Warning System). The mandate for stronger collaboration is the importance of control of zoonoses, and the neglected zoonoses in particular, for poverty alleviation.

Community engagement and health systems strengthening

The Declaration of Alma-Ata (1978) is testimony to a long held global recognition of the need to engage with communities to strengthen health systems (Annex 2, Box 1). There is growing investment by donors in community systems strengthening programs to achieve public health objectives as evidenced by the following examples.

Some examples of initiatives, tools and resources for health systems strengthening¹⁶

Public health	Animal health
Africa Health Strategy: 2007 – 2015 Asia Development Bank Greater Mekong regional communicable diseases control project	Consortium of International Agricultural Research Centres and research programs on: Enhancing Food Security through Staple Foods. The livestock component is being led by the International

¹⁶ Further to the EcoHealth, One Health and other examples in Annex 1, the WHO, FAO and OIE examples in Annex 2, the case study examples in Annex 5 and examples in the database. The electronic version of this report includes links to websites for each of the listed initiatives/tools/resources.

<p>Asia Pacific Strategy on Emerging Diseases (WHO 2011)</p> <p>CARE community based surveillance program in Vietnam, Cambodia, Laos and Myanmar (AUSAID funded)</p> <p>Canada-Asia Regional Emerging Infectious Disease Project</p> <p>Community Systems Strengthening Framework (part of the Global Fund to fight AIDS, Tuberculosis and Malaria)</p> <p>Country Planning Cycle Database (WHO resource)</p> <p>East African Integrated Disease Surveillance Network</p> <p>Global Alliance for Vaccines and Immunisation</p> <p>Integrated Control of Neglected Zoonoses (ICONZ) and particularly Work Package 10: Cultural aspects, gender issues, traditional knowledge and messaging</p> <p>International Health Partnership (IHP+) to drive collaboration at the national health system level</p> <p>Mekong Basin Diseases Surveillance (MBDS)</p> <p>The AsiaFluCap Project</p> <p>Resource mobilization: A practical guide for research and community-based organizations</p>	<p>Livestock Research Institute (ILRI)</p> <p>Policies, Institutions and Markets to strengthen food security and incomes for the rural poor being led by the International Food Policy Research Institute (IFPRI) and involving ILRI</p> <p>Development of Livestock Emergency Guidelines (LEGS)</p> <p>Forum for Agricultural Research in Africa</p> <p>Global Early Warning System (GLEWS)</p> <p>Global Forum for Agricultural Research</p> <p>Global Framework for the progressive control of Transboundary Animal Diseases (GF-TADs)</p> <p>ILRI program on Markets, Gender and Livelihoods</p> <p>Integrated Control of Neglected Zoonoses (ICONZ)</p> <p>The Smallstock in Development Toolbox</p>
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3 Key researchable areas for health systems strengthening

The following summary provides a range of examples of researchable areas for health systems strengthening. It is intended to be indicative, rather than exhaustive.

Public health	Animal health
<ul style="list-style-type: none"> • What are the ways in which primary health care addresses social issues such as participation and empowerment and how might this apply to the prevention and control of zoonoses? • What are the ways in which zoonoses prevention and control can be better integrated with the broader determinants of health such as sanitation or female literacy? • What incentives and mechanisms are required to strengthen inter-sectoral linkages for improved zoonoses prevention and control? • What are the options for strengthening health system capacity for disease surveillance and investigation and how might they be progressed? • In what ways is the private health sector expanding and what are the implications for smallholders and zoonoses prevention and control? 	<ul style="list-style-type: none"> • What are the ways in which zoonoses prevention and control can be better integrated with the development of livestock production systems and value chains for smallholders? • What are the options for strengthening system capacity for disease surveillance in animals and how might they be progressed? • In what ways is the private agricultural sector expanding and what are the implications for smallholders and zoonoses prevention and control? • How and to what extent are national programs for animal health impacting at the village level? • What are the social, health and economic impacts of zoonoses and associated implications for animal health system governance and resourcing?

<p>control?</p> <ul style="list-style-type: none"> • What are the implications of the health, social and economic impacts of zoonoses for public health system governance and resourcing? • In what ways could access to the most vulnerable and at risk populations from livestock related zoonotic diseases be improved? 	<ul style="list-style-type: none"> • What factors contribute to success at the national or village level for zoonoses prevention and control in animals? What are the similarities and differences between countries or villages and the associated changes over time? How might these explain differences in outcomes? What are the implications for animal health systems strengthening at the national or village level?
<p>Community engagement and health systems strengthening</p>	
<ul style="list-style-type: none"> • What are the ways in which civil society organisations (CSOs) participate in zoonoses prevention and control? What incentives and mechanisms are required to strengthen CSO participation? • What are the ways in which CSOs address social issues such as participation and empowerment and how might this apply to the prevention and control of zoonoses? • What models for community development could be applied in the context of zoonoses, smallholder livestock systems and poverty alleviation (e.g. are resilience models relevant)? 	
<p>Social and cultural factors and health systems strengthening</p>	
<ul style="list-style-type: none"> • What social and cultural factors are associated with disease transmission and how might they be influenced for more effective disease prevention and control? • How can social issues around interpretation, information and communication be better understood and managed? • What systems exist for mobilising community resources and how might they be harnessed? • What are the social and economic costs and benefits of diseases and disease interventions? 	

4. Challenges and opportunities for research for system strengthening

<i>Challenge</i>	<i>Opportunity</i>
<p>Discipline driven and supply driven research agendas which are at odds with systems strengthening orientation.</p> <p><i>Donors and researchers may struggle to put communities and their needs at the centre of the system of investigation.</i></p>	<p>Seek critical feedback from the key actors in the system at the research design phase.</p>
<p>Interdisciplinary versus multidisciplinary versus transdisciplinary approaches to research.</p> <p><i>There are inherent challenges in working between and across disciplines.</i></p>	<p>The role and contribution of researchers needs to be articulated.</p> <p>For example researchers may need to expand their role beyond technical input to include facilitating linkages among stakeholders across the value chain.</p>
<p>Constrained resources and capacity within sectors is a major constraint for collaboration between sectors, and including between government agencies and CSOs.</p>	<p>Develop the evidence base to justify collaboration and coordination across sectors.</p>
<p>Confusion about what systems strengthening</p>	<p>Scientists and decision-makers to provide</p>

<p>means and how it is used.</p> <p><i>This creates duplications, inefficiencies and complexities for how the research might be used.</i></p>	<p>conceptual clarity and use evidence-based approaches.</p> <p><i>For example Remme et al. (2010) distinguish operational, implementation and system level research.</i></p>
<p>Confusion about the type and level of engagement with stakeholders in the system.</p> <p><i>For example approaches labelled collaborative are commonly consultative and this may limit the value of the research and lead to unintended consequences.</i></p>	<p>The pro's and con's of consultative, cooperative, collaborative and full partnership approaches need to be assessed.</p>
<p>Confusion about the users and beneficiaries of research and how they relate to each other.</p> <p><i>For example research proposals may identify smallholders and communities as the beneficiaries of research. However the beneficial link may be tenuous where the research products (e.g. publications, decision-support tools) are directed to academic or government organisations.</i></p>	<p>Seek critical feedback from the key stakeholders in the system at the research design phase.</p>
<p>Lack of alignment between program goals, project activities and the needs of communities.</p> <p><i>Many development-oriented research programs define highly aggregated overall goals, but lack a clear strategy to achieve the desired impacts with gaps in logic between defining the research outputs and how they will contribute to the stated goals.</i></p> <p><i>There may also be major gaps between the high level goals and objectives of development programs and the local needs of communities.</i></p>	<p>Consider the governance of research programs and how decisions are taken about research priorities (and including the range of perspectives that are considered in the decision making process); and the frameworks and decision tools used for linking project activities to program goals.</p>
<p>Extending the benefits of systems strengthening research beyond the immediate research context.</p>	<p>Consider strategies for up-scaling at the research design phase and the implications for institutional involvement in the research and the role of key stakeholders.</p>
<p>Limited scope or perspectives in framing the problem.</p> <p><i>The multiple perspectives of the different actors in the system may not be properly addressed which may limit the utility of the research and lead to unintended consequences. Related questions are "problem for who?", "is this really important?" and "who decides the research questions?"</i></p>	<p>Seek critical feedback from the key actors in the system at the research design phase.</p>
<p>Limited scope or perspectives in framing the system.</p> <p><i>Research goals for poverty alleviation and/or zoonoses management require coordinated and collaborative action across sectors. However systems strengthening research is often restricted to one sector, and often one part of the sector (e.g. government sector).</i></p>	<p>Seek to define the system relevant to the development or research goal and all the actors in the system.</p> <p>Take strategic, scenario-based approaches to research design to assess and better understand system level effects.</p>
<p>Tension between the competing priorities of stakeholders.</p> <p><i>For example for avian influenza, donors and governments may prioritise increasing laboratory</i></p>	<p>Seek to define the system relevant to the development or research goal and all the stakeholders in the system.</p> <p>Take strategic, scenario-based approaches to</p>

<p><i>capacity above paying compensation to farmers who have infected poultry or investing in community based systems which may provide less visibility, take longer to achieve success and may target more marginal populations with limited political influence.</i></p>	<p>research design to assess and better understand system level effects. Seek critical feedback from the key actors in the system at the research design phase.</p>
<p>Working with the multiple perspectives and agendas that exist in communities. <i>This includes coordinating the multiple stakeholders seeking to engage in community systems strengthening, and overcoming the difficulty of incorporating non-formal stakeholders in systems strengthening.</i></p>	<p>As above. Extend systems scope to recognise the role of non-formal stakeholders and systems and the potential impact of any interventions.</p>
<p>Fragmentation versus integration. <i>The research process teases apart elements of a system rather than looking at how the parts could better operate together.</i></p>	<p>Seek critical feedback from the key actors in the system at the research design phase.</p>
<p>Developing better methods for outcome and impact assessment. <i>Assessing the costs and benefits of research, and including assessment for a given project or program, and the potential to extend the benefits to other settings is necessary to attract investment in the project or program.</i></p>	<p>Adequately resource the evaluation function, and with appropriate tools and expertise. <i>For example see "Outcome and Impact Assessment of the Global Response to the Avian Influenza Crisis 2005-2010" see http://eas.europa.eu/health/docs/.</i></p>

3.2 LIVESTOCK VALUE CHAINS

1 Key messages for research on livestock value chains

- Research on livestock value chains is increasingly being used to study the risks and impacts of animal and zoonotic diseases on livestock systems, and to develop more appropriate interventions which target areas of highest risk and highest return for disease control. Value chain approaches integrate social and economic analysis, epidemiology and risk management.
- This research should identify and address the way that institutions, policies and stakeholders can strengthen profitable value chains and improve disease control with an appropriate and targeted mix of market assurance programs, incentives/disincentives and adequate regulation. Programs and policies that impact on value chains need to be flexible, resilient and adaptable to changing market requirements, livestock production systems and emerging zoonotic disease risks.
- Obstacles to the use of value chain analysis in zoonoses-related research, such as lack of communication between economists and disease control specialists, need to be weighed against the benefits, which may include more targeted control of zoonotic diseases, more effective interventions which accommodate complexity, more stakeholder participation and less regulation throughout value chains, and increased likelihood and capability for translating research into improved practices.

2. Discussion

What do we mean by value chain approaches?

Value chain approaches are increasingly being used to study the risks and impacts of animal and zoonotic diseases on livestock systems, and to develop more appropriate interventions which target areas of highest risk and highest return for disease control. Value chain approaches integrate social and economic analysis, epidemiology and risk management.

In the FAO *Guidelines for value chain approaches to animal diseases risk management* (2011), value chain analysis is defined as ‘understanding the livestock production systems and how the stakeholders operate and the decisions they make within the livestock production systems’ and this is integrated with risk analysis which is the ‘evaluation of disease risks within the livestock production systems in question and of measures to reduce those risks’. It is also suggested that this approach should be risk-based and people-centred. The terms ‘value chain’ and ‘market chain’ are often used interchangeably and the former will be the term used in this chapter. Value chain approaches also include analysis of social and cultural practices and disease epidemiology, in addition to the production chain. Other key references used in this chapter include Rushton (2012), Rich and Wanyoike (2010), Heffernan (2009), and Schelling et al. (2007).

The value chain approach recognises that animals and livestock products flow through a chain from farm to consumer. It recognises that the chain is a complex system of multiple transactions that is influenced by social, cultural and economic drivers and relationships. Relationships need to focus on cooperation among stakeholders rather than competition. There are variable impacts of diseases in different livestock management sectors (Heffernan 2009). The products, monetary values and disease risks are inter-related and often flow in different directions or are located at different parts of the chain. This leads to a need to identify beneficiaries and losers in relation to the impacts of diseases and also the impacts of disease control measures. For these reasons the benefits and losses along the chain can be uneven and issues of private and public good need to be addressed.

Why research targeted to livestock value chains?

Research can support value chains by contributing to the development of:

- Systems that align the value chain and animal health systems to make the supply chain more healthy and profitable.
- An appropriate and targeted mix of market assurance programs, incentives/disincentives and adequate regulation.
- Programs and policies to support the value chain that are flexible, resilient and adaptable to changing livestock production systems and emerging zoonotic disease risks.

Research on livestock value chains is important to:

- Identify the relevant institutions, stakeholders and policies; their characteristics and role in the value chain; the associated risks and drivers of zoonotic diseases; and opportunities to develop improved policies and programs to better manage the risks.
- Develop research and development frameworks which better integrate improving production systems with improving zoonotic disease prevention and control.
- Assess social and economic impacts of zoonoses on sectors of the production system and small holders in particular.
- Assess social and cultural factors in zoonotic disease prevention and control, for example associated with marketing, or human-animal interactions.

Value chain approaches can provide a useful framework for prioritizing research on zoonotic disease and for developing inter-disciplinary and inter-sectoral approaches to address institutional, policy and stakeholder issues associated with zoonoses (Rich and Wanyoike 2010). Schelling et al (2007) suggest that ‘a research agenda on zoonoses of the livestock sector should be interdisciplinary and participatory and include intersectoral collaborations, notably between the livestock and public health sectors’.

Contexts for research on livestock value chains

Value chain approaches to research involve analysis of the whole production system and the influence of and impacts on stakeholders at all points in the chain.

Researchable issues have been identified for four contexts where value chain approaches can be used to strengthen institutions, policies and stakeholders (see section 2 in this chapter for examples of researchable issues for each of the contexts):

1. **Changing production systems.** This is particularly important in developing countries where small holder production is important for food security and poverty alleviation. At the same time there are pressures to move to commercial farming options. There is a need to study value chains and address critical points for disease risk in low resource settings (Samaan et al. 2011).
2. **Emerging supply systems** and associated opportunities and obstacles for small holders to engage with higher return market systems.
3. **Improvement of health, welfare, food security and poverty alleviation.**
4. **Overlapping of production systems and human population with the environment.** Increasingly emerging infectious zoonoses are arising at the interface between animals, humans and the environment (wildlife). Much of this is due to livestock production systems and associated human activity encroaching on previously forested areas.

Further information is provided in a case study that describes a value chain approach to control highly pathogenic avian influenza in small holder systems in Indonesia and Thailand (Annex 5), and in the database.

3 Key researchable areas for livestock value chains

Researchable areas identified in FAO guidelines (2011) relevant to each of the contexts above
<ul style="list-style-type: none"> Processes within production and marketing systems that carry risk for disease spread, and their relative contributions to risk. Those production systems that carry more risk and therefore require more regulation or intervention e.g. studying the relative importance of backyard and commercial systems for HPAI. People who are most affected by risky processes and identifying who has most to gain or lose through interventions. How stakeholders can intervene to effectively manage risk for livestock production. Targeting surveillance and identifying risk “hotspots”.
Changing production systems
<ul style="list-style-type: none"> Impacts on small holders resulting from commercialisation Impacts of producing alternative products Impacts on the emergence or control of zoonoses in different production systems Identifying and prioritising risks Developing risk management strategies for highest risk threats Impacts on stakeholders and distribution of income Gains and impacts including those displaced by the changes Opportunities for whole of chain cooperation to assist vulnerable parts.
Emerging supply systems
<ul style="list-style-type: none"> Impacts of new commodity supply chains Requirements to comply with quality assurance systems Compliance with standards and guidelines for movement of safe product or livestock (OIE , Codex (Codex Alimentarius Commission) and requirements by trading partners Livestock identification and traceability Understanding risks and drivers for zoonotic disease risk Understanding the risks, management options, costs and benefits from movements of livestock products along the relevant value chain Use of social and cultural research approaches (Martin et al. 2011) Risk analysis.
Improving health, welfare and food security and with relevance to poverty alleviation
<ul style="list-style-type: none"> Health and welfare of livestock owners and their communities

<ul style="list-style-type: none"> • Need to improve nutrition and food security • How to reduce the risks of zoonotic diseases • Use of interdisciplinary and inter-sectoral approaches (Schelling 2007) • Influences of and impacts on social and cultural systems • Need to reduce poverty.
<p>Overlapping of production systems, human populations and the environment</p>
<p>Understanding and addressing the risks of emerging infectious zoonoses associated with:</p> <ul style="list-style-type: none"> • Interaction between small holder livestock systems, humans and wildlife • Transport of wildlife through villages on the way to markets • Transmission of diseases through interaction between wildlife and livestock.

4. Challenges and opportunities for research on livestock value chains

<i>Challenges</i>	<i>Opportunities</i>
Fragmented approaches to research.	More focussed strategies for surveillance, disease prevention and control.
Current approaches have limited impact and sustainability.	Greater chances of success Improved chances of implementation and shorter lead times for implementation of research outcomes.
Few benefits to stakeholders.	Value chain can provide many benefits and these will be more focused and relevant. There needs to be consistency with poverty reduction effort.
Limited resources and local research capacity.	Resources and skills from a range of disciplines. Greater chance of external support.
Many research settings are complex and social and cultural aspects are not always readily apparent.	Complexity can be dealt with by Interdisciplinary approaches. Development and use of appropriate methodologies.

3.3 ECOSYSTEMS, NATURAL RESOURCE MANAGEMENT AND LIVESTOCK SYSTEMS

1 Key messages for research on ecosystems, natural resource management and livestock systems

- Zoonotic diseases are influenced by changes to ecosystems, resource management and livestock production systems. Knowledge of these interactions is important for guiding institutional, stakeholder and policy responses to zoonotic diseases in smallholder livestock systems.
- Interdisciplinary research, involving social scientists, economists, environmental scientists and other disciplines is needed to understand and address the complex interactions between land use, ecology, livestock management systems and emergence of zoonotic diseases.
- There is a need to build capacity in developing countries for interdisciplinary and multi-sectoral research. Associated challenges are to ensure research efforts are well coordinated and focussed in areas of priority importance to stakeholders for the sustainable development of smallholder livestock systems.
- Health, agriculture and environmental agencies will need to work together to address these issues.

2 Discussion

Ecosystem change

Livestock production systems and associated human activity are increasingly encroaching on or sharing previously forested areas. This trend is contributing to zoonotic disease emergence as well as other ecosystem impacts. The pressures for land clearing are being driven by rapidly growing population pressure, the associated demand for food and increased market and trade opportunities. As well as this, climate change and variability are changing the ranges of many disease vectors and hosts, with unpredictable consequences for zoonosis emergence.

Natural resource management systems

Natural resource management (NRM) involves the sustainable management of land, water, plants and animals that are part of the natural industries such as agriculture, fisheries and forestry. It also takes into account economic, social, ecological and environmental issues including biodiversity and conservation. The current status of NRM is described in 'The state of the world's land and water resources for food and agriculture - managing systems' (FAO, 2011a). NRM systems are influenced by globalisation, urbanisation, population growth, movement of people and their effects on land use. Other factors include changing social systems and cultures, increased industrialisation and intensive production of livestock, unsafe feeding practices, water supply variation and environmental and soil degradation. Engagement of NRM managers in zoonoses control and prevention may be needed particularly where wildlife are involved.

Livestock management systems

Livestock production systems vary in intensity from pastoral and small holder systems to fully intensive systems (FAO, 2011b). In developing countries small holder production continues to be important for food security and livelihoods. Small holders are therefore a very important target for research on poverty alleviation. However, if not carefully managed, development which is aimed at poverty alleviation can lead to intensified livestock production which can increase the risks of zoonotic disease as well as environmental degradation. The environmental damage can in turn lead to further poverty, overcrowding and disease risks. Accordingly research on zoonoses prevention and control needs to consider the social, health and environmental impacts of increasing commercialisation and intensification of livestock production.

Changes to ecosystems, natural resource management, and livestock production systems is contributing to the emergence of zoonotic diseases

Ecosystem and social changes are contributing to increasing emergence of infectious disease with more than 60% of emerging infectious disease (EID) events being zoonotic (Jones et al, 2008). Significant changes include encroachment of ecosystems by people and livestock, increasing movements of people, livestock and livestock products, which are in turn driven by growing human populations, urbanisation, industrialisation and demand for animal sourced protein (ASP) (Perry et al, 2011). These changes have contributed to the emergence and re-emergence of infectious diseases, including zoonoses (e.g. HIV/AIDS, SARS coronavirus, nipah virus, ebola virus, influenza viruses such as H5N1 and H1N1, waterborne pathogens), many of which have caused severe economic, health, trade and social impacts.

Government agriculture and environmental agencies must work together for the sustainable development of agriculture and management of natural resources, and also address risks of disease emergence.

Environmental, population and resource pressures are forcing governments world-wide to rethink their policies for the sustainable development of agriculture and the management of natural resources. Such policies, often enacted through macro- and micro-economic policy, influence the development and regulation of trade, land use, and livestock production systems and value chains, and ultimately farmers' choices and decisions (Schillhorn van Veen TW, 1999). Managing the risks of zoonoses and disease emergence is part of this evolving, complex policy equation. A major challenge for governments of resource poor and resource rich countries is for agriculture and environmental agencies to work together to better integrate policy and regulatory functions in this area. International organisations are also addressing this challenge, e.g. Asia-Pacific Economic Cooperation (APEC), Secretariat of the Pacific Community (SPC) and FAO (FAO 2011a, FAO 2011b).

Interdisciplinary research can address important knowledge gaps in understanding the interactions between ecosystems, NRM and livestock production systems and impacts on disease emergence, and also to develop institutional, stakeholder and policy responses that are appropriate for the sustainable development and/or transition of smallholder livestock systems.

Research on zoonoses has traditionally been conducted by specialists in the health and biomedical disciplines and with a health sector focus on disease diagnosis and treatment or measures for disease prevention and control. In recent decades there has been growing awareness of EIDs and the complex systems contributing to disease emergence.

Research can usefully be directed to assisting government agencies, agro-industry organisations, small holder farmers and civil society organisations to better understand the issues of zoonoses and disease emergence and to find better ways of working together to address the issues. Better understanding of the risks and consequences of zoonoses is required and with a view to developing more appropriate interventions for disease prevention and control. Participatory approaches to research will ensure relevance to and ownership by stakeholders, and will increase the likelihood of creative and sustainable solutions to disease problems. Interdisciplinary research is required to better address the complexity of disease emergence and this in turn requires the involvement of social and environmental scientists, economists and other disciplines.

EcoHealth and One Health approaches are important emerging paradigms for research to better understand and manage disease risks at the animal-human-environment interface.

See Annex 1 and the heading 'Socio-ecological systems research and applications' for further information about:

- institutions and stakeholders leading socio-ecological systems strengthening relevant to poverty alleviation, zoonoses and smallholder livestock;
- associated key researchable issues;

- lessons learned from ecosystem approaches for managing zoonoses; and
- examples of initiatives, tools and resources for socio-ecological systems strengthening.

Annex 1 also provides information about social and cultural factors, governance and resourcing and the 'One Health' movement that is relevant to this cross cutting theme, and with specific reference to research contexts, researchable issues and key institutions, stakeholders and policies.

A priority is to build capacity for inter-sectoral and interdisciplinary research.

There are many capacity-related challenges for zoonoses prevention and control that address inter-sectoral impacts on ecosystems, land use and livestock production systems. These challenges can be even greater in resource poor regions such as Sub-Saharan Africa, South Asia and Southeast Asia because ecosystems and livestock management systems may be under pressure for example because of rapid population growth, increasing demand for animal source protein, unregulated intensification of livestock systems and in an environment of limited economic and social resources.

Notwithstanding these challenges, there is widespread recognition that governments and communities need new approaches to managing the risks of disease emergence. It is not only necessary to respond to the last 'new disease' but also to prepare for the next 'new disease'. Government agencies, agro-industry organisations, farmers and communities need to work together to develop innovative livestock and resource management systems for the prevention, early detection and rapid response to the next important zoonotic disease. A focus on managing high risk ecosystems, livestock production systems and human environments is necessary.

Examples of inter-sectoral and interdisciplinary approaches to research and development relevant to zoonoses, poverty alleviation and smallholders are available in the database. Further examples are available through the websites of Canada's International Development Research Centre (IDRC), EcoHealth Alliance, International Association for Ecology and Health, ICONZ Integrated Intervention Packages for Clusters of Neglected Zoonoses, FAO Strategic Action Plan for One Health, One Health Alliance of South Asia, One Health Commission, One Health Global Network web portal, One Health Initiative, OneHealthTalk.org, 'Predict', Rift Valley Fever research partnership and The Global Early Warning System (see Annex 1 for further details).

Foresight approaches are also being applied to managing emerging disease risks (e.g. see <http://hsctoolkit.bis.gov.uk/Welcome.html>). In the introduction to this website on 'Exploring the future: The tools for strategic futures thinking', the head of Foresight for the UK Government Office for Science identifies that foresight science 'will allow you to build on your capacity to understand complex emergent issues, to respond flexibly to uncertainties and to generate innovative and resilient strategies'.

Selected examples of research relevant to ecosystems, natural resource management and livestock production systems include:

- **Chua (2010)** - A review of risk factors, prevention and communication strategies during the Nipah virus outbreak in Malaysia.
- **Karaimu (2012)** - Describes outcomes of a workshop involving veterinarians, epidemiologists, economists and public health experts to align their work and implement more synergetic research on Rift Valley fever.
- **Hewlett et al. (2005)** - A medical anthropological study on Ebola in Congo and the use of political economic and cultural approaches.
- **Wolfe et al. (2005)** - Bush meat hunting, deforestation, and prediction of zoonoses emergence. Emerging Infectious Diseases.

- **Karesh et al. (2005)** - A study of the wildlife trade and global emergence of infectious diseases.
- **Schelling et al. (2007)** - Discusses research approaches for improved pro-poor control of zoonoses of the livestock sector and emphasises the need for interdisciplinary, participatory and include intersectoral collaborations and particularly between the livestock and public health sectors.
- **Kang'ethe et al. (2007)** - A review of publications on urban and peri-urban agriculture and discusses human health, constraints and policy issues.
- **Gutierrez AP. et al. (2009)** - Describes the eco-social consequences and policy implications of disease management in East African agro-pastoral systems.
- **Hogerwerf et al. (2010)** - Describes the effect of agro-ecological niche on the persistence of highly pathogenic avian influenza H5N1 virus.
- **The UK Government's Foresight Project on Global Food and Farming Futures (2011)** The Synthesis Report C13: Maintaining biodiversity and ecosystem services while feeding the world addresses the complex relationships between the livestock sector, ecosystems and the natural resources from a foresight perspective.
- **Global Trends in emerging infectious diseases (Jones et al, 2008)** - describes a study of global trends in emerging infectious diseases and uses an innovative new approach to targeting zoonotic diseases at their source. The approach focuses on the ecosystems and management systems that contribute to emergence of zoonotic diseases. The research is relatively high level and has been used to identify hot spots and sources of zoonoses including zoonotic pathogens from wildlife, zoonotic pathogens from non-wildlife, drug resistant pathogens and vector borne pathogens, and the locations, ecosystems and livestock systems where research could be done. The approach is at an early stage of development and provides opportunity for further research. There is also a need to use similar approaches at the ecosystem and production system levels.

Further information resources are provided in the database, and in a case study (Annex 5) on Rift Valley Fever, a vector borne viral zoonosis that can cause severe disease in both animals and humans and has significant impacts for small holder livestock owners. It shows the need for research to improve climate models, vaccines and societal factors around vaccine uptake.

3 Key researchable areas

Ecosystem change
<ul style="list-style-type: none"> • Examination of the role of wildlife trade and its interface with small holder and rural populations e.g. transport of wildlife through villages on the way to markets (JAVMA, 2012). • Assessing the risks of transmission of disease through bush meat trade (Karesh and Noble, 2009). • Study of global trends in emerging infectious diseases (Jones et al, 2008), and the influences of factors such as transport, species interfaces and population density. • Targeting research and surveillance to 'hotspots' (areas of increased risk of disease emergence). • Incorporating foresight and future science perspectives on ecosystem change in development programs. (http://hsctoolkit.bis.gov.uk/Welcome.html).
Natural resource management systems
<ul style="list-style-type: none"> • Increasing understanding of the interaction between zoonoses, small holder livestock systems, environmental systems and natural resource management systems and the implications for social, environmental and economic development. • Assessing the risks of disease emergence in smallholder livestock systems associated with changing NRM

<p>practices.</p> <ul style="list-style-type: none"> • Developing community-based models for zoonoses prevention and control that balance social, economic and environmental development objectives.
<p>Livestock management systems</p>
<ul style="list-style-type: none"> • Minimising the impacts on small holders resulting from commercialisation, urbanisation and ecological change. • Study of the emergence or control of zoonoses in different production systems. • Improving understanding of the impacts of zoonotic diseases on livestock management systems and options for disease prevention and control. • Developing risk management strategies for zoonotic diseases that are acceptable and appropriate for smallholder livestock systems. • Developing risk based approaches to surveillance, prevention and control. • Identifying production systems that carry more risk and therefore require more regulation or intervention e.g. Studying the relative importance of backyard and commercial systems for HPAI. • Study of the social and cultural impacts of zoonoses in production systems. • Identifying the people who are most affected by risky processes and identifying who has most to gain or lose through interventions. • Assisting institutions and stakeholders to develop policies and intervene to effectively manage risks of zoonotic diseases for livestock production.

4. Challenges and opportunities for research

<i>Challenges</i>	<i>Opportunities</i>
Research in developing countries is constrained by limited capacity and resources.	Build capacity in developing countries for interdisciplinary and multisectoral research. Facilitate entry by international research teams, and their familiarisation with local contexts and professionals. Integrate capacity building into research projects.
Zoonoses are part of complex systems involving interactions between land use systems, ecosystems and livestock management systems.	Complexity can be dealt with by interdisciplinary approaches and use of appropriate methods.
Understanding complex systems requires resources and skills from a range of disciplines.	Research funders to provide resources for complex systems analysis. Integrate capacity building for intersectoral, multidisciplinary and transdisciplinary research into research projects.
Zoonoses-related research and development is often narrow, has limited impact and is not sustainable.	Research funders to promote research with a systems strengthening focus (see Annex 1 for further details).

3.4 SUSTAINABLE MANAGEMENT OF ENDEMIC ZOOSES

1. Key messages for research on endemic zoonoses management

- Many serious endemic zoonoses have been neglected in developing countries as their burden, particularly upon the rural poor, is often severely underestimated. Economic analyses e.g. cost benefit studies, are usually necessary to justify and secure commitment for the long term interventions needed to achieve sustainable control and subsequently allow better economic returns.
- Strategies for sustainable management of endemic zoonotic disease will vary according to the types of diseases, their epidemiology in different locations and their impacts on human, livestock, companion animal and wildlife populations. This in turn will require the engagement of different sets of institutions, policies and stakeholders, often over long periods of time.
- Translating international commitment to tackle previously neglected zoonoses into effective national programs requires careful systems and operational research. Policies need to suit particular economic, social, cultural and environmental conditions at the regional, national and sub-national levels.
- New technical innovations must be assessed as to whether they will deliver improvements. However, old or new technologies alone will not work without sustained political will, commitment and funding, and effective program delivery mechanisms, as well as institutional and community engagement and support for program design, implementation and evaluation.
- Improvements in broader infrastructure such as housing, water supply and sanitation, and / or changes in cultural and animal management practices, may be necessary to break disease transmission cycles, and broad multi-disciplinary research and stakeholder engagement may be needed to identify and optimise these interventions.
- Research is needed on effective capacity building among communities and professionals, as well as in government and non-government organizations. Capacity building can include knowledge and skills development, a supportive institutional framework, and the ability to access resources such as funds and transport.

2. Discussion

Many serious zoonoses have been feared since the dawn of time. They have been eliminated or largely controlled in many developed countries through both sound technical strategies delivered through effective public health and veterinary services, and strong supporting systems including governance, funding, education and broader infrastructure.

Translation of past disease specific strategies and technical measures to developing countries, however, is fraught with difficulty and rarely successful without attention to wider systems contexts which are often community, country or ecosystem specific.

As well, the governance and funding mechanisms in the developing countries where these zoonoses persist are often relatively weak. Strong analysis of the benefits and costs of control or elimination is required, which must also include the costs and benefits of system strengthening.

Research on why tried and true approaches have not worked in specific situations, and on which new approaches are needed, both locally and globally, is critical to achieving national and global goals for more effective control or eradication of these often neglected zoonoses. Broader approaches are needed within which both long-standing and novel technical interventions can be nested.

Contexts for research on strengthening management of endemic zoonoses

There is global level commitment for an accelerated attack on neglected zoonoses (WHO 2012) by:

- (i) expanding or initiating strategy validation field studies in different geographical and epidemiological settings;
- (ii) building national capacity in disease surveillance and diagnosis;
- (iii) initiating large-scale control in priority countries; and
- (iv) mobilizing the necessary resources.

A. Serious zoonoses already eliminated or well controlled in many developed countries

Diseases such as brucellosis and bovine tuberculosis have profound economic effects on livestock owners as well as causing major human health impacts, and are often tackled together. The main drivers for their control are often their severe effects on animal production although their zoonotic effects are also very significant e.g. WHO (1997) estimates that half a million cases of human brucellosis are reported worldwide every year, and that for every case diagnosed, four cases go undetected. Consequently they have been eradicated or are well controlled in most developed countries. Past successful approaches can be examined for their applicability in different developing countries but will need modification, as shown in Box 3.

Rabies has devastating but often poorly documented impacts on the very poor especially in Asia and Africa, where failure to control it effectively in dogs, the main reservoir host, leads to ongoing deaths which should be preventable. The efficacy of comprehensive canine vaccination programs is becoming increasingly recognized but they are difficult and expensive and national governments often prioritise human treatment over preventive programs in dogs. Research on effective program delivery in specific socio-cultural settings is particularly critical to devising effective control programs.

B. Parasitic zoonoses

Parasitic zoonoses are often associated with poverty and ignorance and poor sanitation, housing and livestock keeping / slaughtering practices, with high morbidity and relatively low mortality. They “affect mostly rural smallholder and nomadic communities where there is close interaction between people, their livestock and the environment. Agricultural and public health authorities in the endemic countries usually assign low priority to parasitic zoonoses, primarily due to a lack of awareness of their presence and impact” (Willingham 2002).

For these diseases, in poor countries, elimination will remain a very long term goal with attention being given to transmission control by improved practices, many related to general poverty alleviation and with many health benefits. Community specific research is needed to test the applicability and acceptability of such interventions, to ensure their appropriateness in particular contexts, as well as involvement of many agencies and stakeholders.

Control of several parasitic zoonoses is being improved by mass chemotherapy approaches using donated drugs. As noted by Hotez et al. (2007), this could sustainably reduce poverty but there are many challenges which must be considered. Also notable is the need for very long term and consistent application of strategies with full community involvement and critical appraisal of barriers to success as disease control programs continue (Annex 3 Box 3.4).

C. Zoonoses unlikely to be eradicable

Some zoonoses, such as leptospirosis, cause periodic human and livestock morbidity or mortality and are likely to contribute to the overall burden of disease and economic loss by smallholders. However, their eradication would be technically unfeasible and/or economically unjustifiable, due to the complexity of their epidemiology

and the intermittent nature of outbreaks, so they are unlikely targets for comprehensive large scale control or eradication programs. They are often caused by agents which are endemic in wildlife (and sometimes livestock as well) with occasional spillovers to humans which may become more frequent (emerging or re-emerging) due to ecosystem disturbance, intensification of nearby agriculture or other land use change. Zoonoses with a wildlife reservoir bring a high level of complexity and considerable challenges in developing appropriate policy responses (see Chapter 2 and Annex3 Box 3.5).

Capacity building and education for sustainable endemic zoonoses management

The need for research on capacity building deserves special mention. Capacity building and education is critical for sustainable endemic zoonosis management, and must be built into programs from the start and for the long term. Research into the adequacy of capacity building at every level, among communities and professionals, as well as in government and non-government organizations, is needed to improve the effectiveness of programs and the targeting of scarce resources. Capacity building can include development of knowledge and skills, a supportive institutional framework, and the ability to access resources such as funds and transport. Research into the application of the WHO framework for capacity building to control neglected tropical diseases (WHO 2012) should be useful in many developing countries (Annex 3 Box 3.6).

A case study on brucellosis in Timor shows how the brucellosis control approach used successfully in Australia has needed customization in Indonesia to deal with brucellosis in West Timor, and will need further change to deal with brucellosis in Timor-Leste for a whole-of-Timor-island solution.

A case study on the control of hydatidosis (Echinococcosis) in three countries illustrates the very long term government and community commitment needed to effectively deal with this parasitic zoonosis.

3. Key researchable areas for sustainable management of endemic zoonoses

Serious zoonoses already eliminated or well controlled in many developed countries
<ul style="list-style-type: none"> • Applicability of proven and novel technical and policy approaches in developing country contexts • Mechanisms for mobilising resources to implement long term programs effectively • Capacity to implement selected policies effectively at national and sub-national levels • Participatory research to find culturally appropriate community awareness, engagement and feedback mechanisms • Multidisciplinary assessment of barriers to adoption of recommended disease control practices • Field and laboratory surveillance strengthening
Parasitic zoonoses
<ul style="list-style-type: none"> • Assessments of burden of disease in humans and animals through integrated medical and veterinary field and laboratory surveillance and economic analysis • Research on socio-cultural and animal management practices contributing to disease transmission cycles and means of effecting desirable behaviour change in relevant communities • Monitoring and evaluation of the effectiveness of mass chemotherapy approaches • Engagement of institutions and stakeholders involved in delivering and receiving wider improvements in housing, water and sanitation and assessment of their impacts on parasite transmission rates
Zoonoses unlikely to be eradicable
<ul style="list-style-type: none"> • Research on the availability, maintenance and renewal of appropriate medical and veterinary service diagnostic and risk based surveillance capability • Design and implementation of risk-based communication programs to targeted at-risk groups about means to reduce likelihood of infection and

- Local registration and availability of suitable vaccines or treatments.

4. Challenges and opportunities for approaches to endemic zoonoses management

Challenges	Opportunities
Translating global initiatives for zoonosis control through national and sub-national governments to the community level	Research on adaptive management strategies, responsive to socio-economic and cultural variables in different areas
Sustaining political and community commitment for long term zoonoses control or elimination programs	Research on burdens of disease, prospective and retrospective economic cost benefit analyses of control programs, and effective stakeholder engagement strategies
Securing and maintaining adequate resourcing to deliver effective long term zoonoses control or elimination programs	Research on cost sharing models and international and national budgetary mechanisms which will deliver adequate resources
Appropriate policy and regulatory support for major programs	Research on policy impacts and implementation effectiveness, barriers and success factors in different contexts and areas
Capacity building at all levels – community (children and adults, both genders), professional and government	Research on knowledge, skills and attitudes to zoonotic diseases, their animal reservoirs, and control strategies. Research on effectiveness of existing capacity building initiatives and their improved design
Complexity of intersectoral engagement at all levels e.g. health, agriculture, wildlife, planning, finance agencies	Operational and systems research to identify barriers to intersectoral communication and successful models for managing uncertainty in interdisciplinary decision making and governance of zoonoses control
Evolving local manifestations of many zoonoses in areas of high human and livestock population growth	Research on use of new communication media to improve local surveillance, education and development of tailored solutions to disease outbreaks
Developing smallholder capacity to participate in market supply chains with incentives for provision of safer products to consumers	Participatory research on local organizational structures to facilitate smallholder participation in biosecure market chains

3.5 MANAGEMENT OF ZOOONOTIC DISEASE EMERGENCIES

1. Key messages for research on management of zoonotic disease emergencies

- Outbreaks of serious zoonotic disease, whether new, emerging or re-emerging, constitute emergencies and disasters for the communities and countries in which they occur and should be prepared for and managed accordingly; however this is not always immediately recognised.
- Zoonotic disease emergencies may occur due to:
 - Emergence of new diseases with unknown but potentially severe epidemic potential;
 - Incursions of known zoonotic diseases into countries or districts which had been historically free or had previously eradicated the disease; or,
 - Epidemics of known endemic zoonotic diseases, due to either inadequate preventive or control measures, or unknown but rare ecological events.
- Drivers for strengthening national frameworks for emergency zoonoses preparedness include:
 - Increasing risks of zoonotic disease emergence or re-emergence with increased human and livestock population and increased travel and trade; and
 - Increased global commitment and availability of improved emergency preparedness and response frameworks, new technologies, innovative community engagement models and international funding sources to tackle both newly emerging and previously neglected zoonoses which otherwise can cause disastrous outbreaks.
- The policies, institutions and stakeholders engaged in preparedness for and response to zoonotic disease emergencies are critical to their effective management. These will determine the success or otherwise of management and control efforts at least as much as, if not more than, detailed technical understanding of the disease.
- International disaster management frameworks should and are being applied at the national level in many countries. Effective and implementable national emergency preparedness plans are the key to managing emergency zoonotic disease risks.
- Operational and systems research into adequacy of zoonotic emergency preparedness in different countries can facilitate investments which will increase their long term resilience in the face of future zoonotic threats.

2. Discussion

Contexts for research on management of zoonotic disease emergencies

Serious zoonotic diseases are emerging or re-emerging around the world, with increased human and livestock population, and increased travel and trade. Recent experience with SARS and HPAI particularly has sensitized international organizations and led to the incorporation of emerging infectious diseases (EID) into wider global disaster risk reduction frameworks and strategies.

This in turn has led to increased global commitment and availability of improved emergency preparedness and response frameworks, new technologies, innovative community engagement models and international funding sources, to tackle previously neglected zoonoses which otherwise can cause disastrous outbreaks.

However, inclusion of zoonotic disease outbreaks / incursions in an emergency preparedness and response framework is a major challenge for developing countries, when considered against their many pressing

development needs. Although outbreaks of serious zoonotic disease, whether new, emerging or re-emerging, constitute emergencies and disasters for the communities in which they occur and should be prepared for and managed accordingly, this is not always immediately apparent to resource-poor governments. The disaster of a zoonotic outbreak may occur at several levels, e.g. the damage caused by the disease to human and / or animal health, loss of smallholder income as a result of livestock market disruption, or damage and loss caused by the disease control program. In some cases smallholders will ignore the presence or impact of the disease, but will find the control program a disaster if it means killing their livestock (especially without compensation).

Some zoonoses, with known or observed pandemic, bioterrorism or transboundary potential, are easily assimilated into recognized disaster risk reduction frameworks, and also attract global and national attention. However, because of the insidious manner in which other zoonoses emerge, they may not be recognized as emergencies or disasters until they have spread extensively, compounding the misery and costs of control they eventually cause.

International frameworks International efforts in disaster risk reduction have been crystallized as the “Hyogo Framework for Action: (HFA) Building the resilience of nations and communities to disasters” (Annex 4 Box 4.1). This framework applies to natural disasters such as earthquakes and tsunamis and also directly applies to human disease epidemics.

The International Strategy for Disaster Risk Reduction (ISDR) includes epidemics of human diseases within this framework, however ISDR staff may neglect this aspect to concentrate on natural events, despite data on UN ISDR Preventionweb which show that epidemics are among disasters with high mortality. Significantly the economic costs of epidemics are often not calculated.

At the regional level, ASEAN has created the first legally binding HFA-related instrument with their ASEAN Agreement on Disaster Management and Emergency Response (AADMER). AADMER is a proactive regional framework for cooperation, coordination, technical assistance, and resource mobilization in all aspects of disaster management, including emerging infectious diseases (EID). The AADMER gives priority to disaster risk reduction and proposes the inclusion of all stakeholders such as NGOs, private sector, and local communities as a key to effective disaster management.

From the HFA, global organizations have developed supporting sectoral plans (Annex 4 Box 4.2), e.g. the FAO/WHO framework for developing national food safety emergency response plans(WHO 2010), which contains excellent broad principles highly relevant to zoonotic disease emergencies, and the WHO strategy on health sector risk reduction and emergency preparedness (WHO 2007).

National frameworks A strong framework of national preparedness is the key to managing known disease risks and there are many models around the world. While broad international frameworks have been developed, effective response involves preparedness at national and lower levels. There is also a need for sectoral plans at international and national levels e.g. the UN Medical Directors’ Influenza Pandemic Guidelines (UN 2011), and Australia’s Emergency Animal Disease (EAD) framework (Annex 4 Box 4.2).

Research on policies, institutions and stakeholders involved in zoonotic emergency management

Comparative research is needed to determine the applicability of successful emergency management frameworks to the management of zoonotic disease outbreaks In individual developing countries, and associated gaps in national arrangements and opportunities for integration of action between agencies. Annex 4 Box 4.4 gives examples of some web-available emergency zoonoses preparedness plans and policies

developed in south-east Asian countries and sub-Saharan Africa, and demonstrates the relative lack of inter-sectoral planning in some areas.

Research on **decision making in the face of zoonotic emergencies** is particularly useful for improving risk management and risk communication procedures. Austin et al (2012) point out that:

“ the criteria and timing for policy response and the resulting management decisions are often altered when a disease outbreak occurs and captures full media attention. Political and media influences are powerful drivers of management decisions if fuelled by high profile outbreaks. Furthermore, the strength of the scientific evidence is often constrained by uncertainties in the data, and in the way knowledge is translated between policy levels during established risk management procedures..”

Research on preparedness and response to different types of zoonotic emergencies

A. Emergence of a new zoonosis with severe epidemic potential

In recent years, a number of previously unknown viruses or new recombinant strains of known viral pathogens have emerged and caused major disruption due to their potential to cause global pandemics. Some key examples are SARS, Nipah virus and H5N1 HPAI. Each of these has required both pre-existing and newly developed policies and procedures, and linking mechanisms for institutions and stakeholders, to develop and implement responses, at the local sub-national, national and international levels. Research on the effectiveness of these responses from the perspectives of different stakeholders can yield valuable lessons for future preparedness.

If a previously unknown disease is seen to be causing significant human mortality or morbidity, very stringent medical policies and procedures may need to be applied in the absence of complete or any information about the pathogenicity and epidemiology of the disease.

- Measures to prevent person-to-person spread may require sound medical and hospital barrier nursing procedures as close to the outbreak location(s) as possible. Prior education of frontline medical staff and availability of PPE and appropriate biocontainment facilities are highly desirable.
- Legal powers should be available and implementable to prevent people moving to or from quarantine areas. Medical authorities may require support from police.
- Governments and politicians must be helped to understand the necessity for such measures, and for how long they may be required.
- Risk communication to the affected and potentially affected communities is needed to support societal response and reduce panic, with attention to social and cultural contexts.
- Global or regional trans-national risk management and reporting measures may be required according to the International Health Regulations (WHO 2007) and the OIE Animal Health Act.

Adequate technical response must also be developed including measures such as :

- Diagnostic criteria and tests.
- Urgent surveillance and applied research to determine the source and extent of the infection.
- Vaccine development and registration if appropriate or feasible.
- Mechanisms to tap into global expertise quickly and efficiently.

When an animal reservoir is suspected and/ or confirmed, or if the main expression of disease is in animals, appropriate short and long term control or eradication measures need to be developed and implemented. Operational and systems research may be needed in the following areas.

- Discovery of livestock and / or wildlife reservoirs creates different implications for action and for involvement of different institutions and stakeholders.
- Policies of stamping out or short or long term movement controls for infected or highly at risk livestock populations may in some situations be technically sound but unfeasible due to market pressures and other issues including:-
 - lack of legally empowered, trained, equipped and supervised field staff;
 - lack of adequate compensation policies or the funds and practical means to implement them;
or
 - Impact of loss of livestock on smallholders' livelihoods and / or cultural practices.
- Value chain analysis of movements of livestock and livestock products, coupled with a disease risk analysis framework and cost benefit analysis of proposed controls and disease impacts, may be urgently needed to devise control programs which do not impose unnecessary burdens on smallholder farmers and others in the value chain, leading inter alia to non-compliance with poorly devised programs;
- Cultural and social implications and acceptability of disease control actions in different livestock sectors may need careful examination at many local and sub-national levels;
- Involvement of wildlife in the disease epidemiology will raise a wide range of ecological and sometimes social issues depending on the species and environments involved. Prospects for compartmentalization and reduction of risky contact between wildlife reservoirs and people and/or susceptible livestock will need assessment.

B. Incursion of a known zoonotic disease into a country or part thereof which is historically free or has previously eradicated or effectively controlled the disease

Some zoonotic diseases e.g. rabies, are so feared that they have been well controlled or eliminated from their host animal species in most developed countries, and programs of varying effectiveness operate in many developing countries. Without global eradication, however, risks of incursion and re-establishment remain and may intensify as global trade and travel increase. These incursions may not appear as emergencies at first and hence spread to the point where they become major disasters, diverting scarce medical and veterinary resources from other programs.

Early detection of new incursions of serious zoonotic diseases is the key to their effective control before they cause too much damage and spread too far to be easily and economically containable. Research is needed into novel and cost –effective ways to deliver early detection (e.g. Desktop Flutracker for community based surveillance, “a tool that allows users to conveniently and accurately track the appearance and spread of flu in any community in the continental United States <http://www.tamiflu.com/flutracker/>) and the availability of :

- Health and veterinary / agriculture services which are aware of potential major disease risks and ideally have some surveillance programs for them.
- Community capacity building and education about key disease risks and reporting mechanisms.

- Field staff or community members who can respond to community concerns or observations , and either report to health / veterinary services or collect adequate specimens and transport them to be tested.
- Diagnostic facilities with equipment, reagents, trained staff and quality assurance procedures.

Once a serious zoonotic incursion has been diagnosed, application of appropriate technical measures is desirable as quickly as possible, to contain and if possible eliminate the disease from the recently infected area. A number of key non technical elements are also needed, namely:-

- Appropriate legal powers, instruments and policies to implement them, based on contingency / preparedness plans for dealing with such incursions, ideally agreed jointly by senior government agencies and other relevant stakeholders .
- Mechanisms for providing emergency funding, including cost-sharing arrangements between key stakeholders, to address such incursions adequately and in a timely manner.
- Mechanisms / policy framework to ensure high level commitment and coordination of government and other stakeholders to support decision making and funding of economically and technically preferred control / eradication options.
- Arrangements for organization of emergency response which are easily understood / grafted onto existing government structures .
- Trained staff in relevant agencies who can initiate / manage the response.
- Economic expertise to conduct prospective / retrospective cost:benefit analysis.
- Planning and project management expertise and authority to develop and implement agreed long term disease control measures /programs.
- Budgets to assist in control, and compensation to animal owners where culling occurs.

Prospective research into the availability of these elements and their customization to local conditions, particularly at the national and sub-national levels, is highly desirable.

C. Epidemics of known endemic zoonotic disease, due to either inadequate preventive or control measures, or unknown but rare ecological events.

Some endemic and effectively ineradicable zoonotic diseases such as anthrax periodically cause unexpected outbreaks in areas not suspected of being infected, which should if possible be handled as emergencies to reduce risks. Likewise the possibility exists of future emergence of rare but known diseases such as SARS in new ecological niches. These outbreaks ideally require:-

- Rapid response based on contingency plans, sound policy, adequate funding and stakeholder commitment;
- Retrospective risk analysis of why the epidemic(s) occurred including the impact of ecological, social and cultural factors;
- Development and implementation of new policies and procedures customized to the local situation and then generalized to prevent or promptly respond to further epidemics in future over as wide an area as possible; and
- Capacity building particularly in at risk communities and the professionals and agencies which serve them.

Prospective research on the adequacy of national and sub-national preparedness and the capacity of smallholder communities to respond to such outbreaks is highly desirable.

Case studies

A case study of the emergence of Nipah virus and different responses in Malaysia and parts of South Asia illustrates the complexity of the policy responses, institutional involvement and stakeholder engagement required to a previously unknown zoonotic disease in different ecosystems.

A case study of management of several rabies incursions in Indonesia and Africa, nested in a wider background of rabies management in Africa, illustrates the impact of different dog : human ecosystems on drivers for rabies spread and persistence, the difficulty of mounting timely responses to incursions and particularly of amassing sufficient resources to mount effective rabies control programs.

3. Key researchable areas for management of zoonotic disease emergencies

Operational and systems research is needed on many issues including:-	
<ul style="list-style-type: none"> • Application of international disaster risk reduction frameworks in regional, national and sub-national plans for severe zoonotic outbreaks • Sectoral and intersectoral awareness of zoonotic potential to cause disasters and multi-stakeholder involvement in policy formulation for prospective outbreaks • Risk assessments allowing prioritisation of zoonotic emergency disease threats • Availability of disease outbreak preparedness plans and policies which have been agreed by all relevant agencies • Availability of agreed emergency funding and decision making arrangements to allow outbreak response plans to be implemented • Capacity of national and local staff, value chain participants, livestock owners and communities to respond effectively • Evaluation of mechanisms and implementation procedures for compensating owners for livestock destroyed in stamping out programs • Availability and application of vaccines etc to combat specific diseases 	

5. Challenges and opportunities for zoonotic emergency management

Challenges	Opportunities
Developing rapid response systems which can work at national and sub-national levels	Assessing the applicability of proven rapid response models in different developing country contexts
Customising zoonoses emergency control policies to suit local conditions	Assessing the economic, social and cultural implications of proposed or existing policies
Including zoonotic emergencies in national disaster risk reduction plans	Assessing the economic, social and cultural impacts of zoonotic epidemics and mechanisms for inclusion in disaster reduction frameworks
Finding mechanisms for rapid resourcing of zoonotic emergency responses	Assessing cost-sharing arrangements between international and national agencies which will

	support timely control and eradication programs for zoonotic emergencies
Giving legal authority for necessary rapid control action for zoonotic emergencies which are appropriate for developing countries	Determining successful legal arrangements in place around the world and sharing lessons learned
Evidence-based decision making in the face of uncertainties	Research on effective rapid decision making by relevant local, national and international institutions
Capacity building at all levels for emergency preparedness and response	Research on best and most cost effective systems and impacts of past activities

4 APPENDICES

APPENDIX 4.1 LIST OF ACRONYMS / ABBREVIATIONS

AADMER	ASEAN Agreement on Disaster Management and Emergency Response
ACIAR	Australian Centre for International Agricultural Research
AFENET	African Field Epidemiology Network
AFROREB	Africa Rabies Expert Bureau
AI	Avian Influenza
AU-IBAR	African Union Interafrican Bureau for Animal Resources
BAWA	Bali Animal welfare Association
BBPCP	Bovine Brucellosis Progressive Control Programme
BERM	Basin Excess Rainfall Maps
BTECC	Brucellosis and Tuberculosis Eradication Committee
CAREID	Canada-Asia Regional Emerging Infectious Disease
CFIA	Canadian Food Inspection Agency
CSIRO	Commonwealth Scientific Industrial Research Organisation
CSO	Civil Society Organisation
DALY	Disability Adjusted Live Year
DFID	Department for International Development
DOC	Day Old Chick
EAD	Emerging Animal Disease
EID	Emerging infectious disease
EIVSP	Eastern Islands Veterinary Services project
EMPRES	Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases
ENSO	El Niño /Southern Oscillation
ICONZ	Integrated Control of Neglected Zoonoses
FAO	Food and Agriculture Organization
FARA	Forum for Agricultural Research in Africa
FERMS	Federal Emergency Response Management System (of Canada)
FETP	Field Epidemiology Training Programme
FMPI	<i>Forum Masyarakat Perunggasan Indonesia</i> (Indonesian Poultry Forum)
GLEWS	Global Early Warning System
GLiPHA	Global Livestock Production and Health Atlas
GOARN	Global Outbreak Alert and Response Network
HACCP	Hazard Analysis Critical Control Point
HFA	Hyogo Framework for Action
HPAI	Highly Pathogenic Avian Influenza
ILRI	International Livestock Research Institute
MDG	Millenium Development Goal
MODIS	Moderate Resolution Imaging Spectroradiometer
NDVI	Normalised Difference Vegetation Index
NGO	Non-Government Organisation
NICPS	Non-Industrial Commercial Poultry Sector
NTD	Neglected Tropical disease
NTT	Nusa Tenggara Timur
NRM	Natural Resource Management
NZD	Neglected zoonotic disease
OFFLU	OIE-FAO Network of Expertise on Animal Influenza

OH	One Health
OHASA	One Health Alliance of South Asia
OIE	Office international des epizooties
PCS	Provincial Steering Committee
PEP	Post Exposure Prophylaxis
PVS	OIE Tool for the Evaluation of Performance of Veterinary Services (OIE PVS Tool)
PSVSS	Program to Strengthen Veterinary Services in South East Asia
R&D	Research and Development
RPA	<i>Rumah potong ayam</i> (poultry slaughterhouse)
RVF	Rift Valley Fever
SARS	Severe Acute Respiratory Syndrome
SEARG	Southern and Eastern African Rabies Group
SPS	Sanitary and Phytosanitary Standards
TAD	Transboundary Animal Diseases
UK	United Kingdom
UNDP	United Nations Development Programme
UNICEF	United Nations International Children's Emergency Fund
WHO	World Health Organization
WSPA	World Society for Protection of Animals
ZEIDS	Zoonoses and Emerging Infectious Diseases
ZELS	Zoonotic and Emerging Livestock Systems
ZEN	Zoonotic Emergence Network
ZIPS	Zoonoses Institutions, Policies and Stakeholders

APPENDIX 4.2 GLOSSARY OF TERMS

Cold chain	A cold chain is a <u>temperature-controlled supply chain</u> . An unbroken cold chain is an uninterrupted series of storage and distribution activities which maintain a given temperature range. It is used to help extend and ensure the <u>shelf life</u> of products such as fresh agricultural <u>produce</u> , <u>seafood</u> , <u>frozen food</u> , photographic film, chemicals and <u>pharmaceutical drugs</u> .
Disability Adjusted Life Year	A measure of overall disease burden expressed as the number of years lost due to ill-health, disability or early death.
EcoHealth	An emerging field of study researching how changes in the earth's ecosystems (biological, physical, social and economic environments) affect human health.
ELISA test	Enzyme-linked immunosorbent assay (ELISA), is a popular format of a "wet-lab" type analytic <u>biochemistry assay</u> that uses one sub-type of heterogeneous, solid-phase enzyme <u>immunoassay</u> (EIA) to detect the presence of a substance in a liquid sample or wet sample.
Emerging Infectious Disease	Infectious diseases whose incidence in humans has increased in the past two decades or threatens to increase in the near future have been defined as "emerging." These diseases, which respect no national boundaries, include: <ul style="list-style-type: none"> • New infections resulting from changes or evolution of existing organisms • Known infections spreading to new geographic areas or populations • Previously unrecognized infections appearing in areas undergoing ecologic transformation • Old infections re-emerging as a result of antimicrobial resistance in known agents or breakdowns in public health measures.
Millennium Development Goals	In 2000, 189 nations made a promise to free people from extreme poverty and multiple deprivations. This pledge became the eight Millennium Development Goals to be achieved by 2015.
Neglected Tropical Disease	The neglected diseases are a group of <u>tropical infections</u> which are especially endemic in low-income populations in developing regions of <u>Africa</u> , <u>Asia</u> , and the <u>Americas</u> . Different organizations define the set of diseases differently.
Neglected Zoonotic Disease	Neglected zoonoses are mainly associated with people living in close proximity to domestic or wild animals. They are usually endemic and found through the developing world where conditions for their maintenance and spread exist. Unlike emerging zoonoses, which attract considerable international attention, the endemic zoonoses are often neglected resulting in considerable health problems. These endemic and occasionally epidemic zoonoses continually affect poor livestock keepers in marginalized communities. Neglected zoonoses, such as anthrax, rabies, brucellosis, bovine TB, zoonotic trypanosomiasis, echinococcosis, cysticercosis and leishmaniasis, are major causes of ill-health in the poorest communities in developing countries in Africa, Latin America and Asia.
One Health	One Health aims to improve health and well-being through the mitigation of risks and crisis that originate at the interface between humans, animals, and their various environments.

APPENDIX 4.3 CATEGORIES AND FIELDS IN THE ZIPS DATABASE

Category	Fields
Region / Country	<ul style="list-style-type: none"> •
Disease / Pathogen	<ul style="list-style-type: none"> • All • African sleeping sickness – Trypanosomiasis – <i>Trypanosoma brucei</i> • Anthrax – <i>Bacillus anthracis</i> • Avian influenza – zoonotic influenza • Botulism • Bovine tuberculosis – <i>Mycobacterium bovis</i> • Brucellosis – <i>Brucella abortus / melitensis</i> • Buffalo pox • Chagas disease – <i>Trypanosoma cruzi</i> • Cysticercosis - <i>Taenia solium</i> • Ebola • Echinococcosis - Hydatid disease • Hendra - <i>Henipavirus</i> • Japanese encephalitis • Leishmaniasis • Leptospirosis – Weil's disease • Mange – <i>Sarcoptes spp</i> • Marburg • Newcastle disease • Nipah • Rabies • Relapsing fever - <i>Borrelia</i> • Rift Valley Fever • Salmonellosis • SARS • Schistosomiasis • Toxocariasis • Toxoplasmosis • Trichinellosis
Livestock System	<ul style="list-style-type: none"> • All • Cattle and buffalo • Poultry • Pigs • Sheep and goats • Wildlife • Other
Research Approaches	<ul style="list-style-type: none"> • Social • Economic • Other
Sector	<ul style="list-style-type: none"> • All • Human Health • Agriculture • Environment / Natural Resource Management • Education • Planning and Development • Social Services • Non Governmental Organisation • Private • Public / Government

Scale	<ul style="list-style-type: none">• All• International• Regional• National• Local
Theme	<ul style="list-style-type: none">• All• Systems strengthening• Livestock value chains• Land use, ecological change and livestock production systems• Sustainable endemic zoonotic disease management• Management of zoonotic disease emergencies

5. THEME CHAPTER ANNEXES

ANNEX 1: BACKGROUND DISCUSSION ON RESEARCH FOR SYSTEMS STRENGTHENING

Considering the complex interactions between zoonoses, humans, animals and the environment, and the aim to encourage people to think more broadly about research, it was thought useful to provide a background discussion on the following related topics:

1. Aims and key considerations for systems strengthening research
2. Systems thinking
3. Socio-ecological systems research and applications
4. Social and cultural factors and systems strengthening
5. Governance and resourcing for systems strengthening
6. 'One Health' movement and systems strengthening.

1 Aims for systems strengthening research

Research for systems strengthening refers to the production of new knowledge or tools to improve system performance to achieve defined benefits for goals. System challenges are multiple and complex and therefore processes to prioritize research are required.

Broad aims for systems strengthening research are to:

- Improve understanding of a situation.
- Support change or continuous improvement.
- Share lessons learned from research that could be relevant to other contexts.
- Define and prioritise system constraints, and research questions to address these.

These aims can be applied to different levels or aspects of a system, for example to:

- Justify and evaluate investment in policy and program development relevant to zoonoses.
- Understand the risks and impacts of zoonoses.
- Develop more appropriate and acceptable response and communication tools and mechanisms.

Some key considerations for systems strengthening research

- Who does the research serve and for what purpose?
 - For example if the research is for policy makers, is the research for agenda setting, policy evaluation, policy testing and implementation, or policy formulation?
- What aspects of the system are to be investigated, and with reference to stakeholders, policies and institutional arrangements.
- What scales need to be considered to investigate the problem / situation? Does the relationship between scales also need consideration?

- Is there a functioning research-development continuum?
 - Who are the key actors who are the drivers and preventers of change in a system?
 - What institutions and stakeholders need to be involved, and when and how should they be engaged, e.g. through consultative, cooperative or full partnership arrangements?
 - How will the research be used and what are the resource implications?
- What types of systems thinking and methods should be applied?
 - For example resilience thinking works to build on strengths in a system rather than overcoming weaknesses. Participatory learning and action research approaches may require researchers to shift from being disciplinary experts to being interdisciplinary facilitators.
- What are the intended and potential impacts of the research? How could these be evaluated?
- What are the risks of the research and how might they be managed?
- What lessons can be learned from the research and how might they apply to the given situation and other contexts?

Further analysis is provided in *Challenges and opportunities for research for systems strengthening*, and examples of research planning tools for systems strengthening are included in the database (e.g. Biggs and Matsuert-2004).

2 Systems thinking and systems strengthening research

Systems strengthening research is informed by systems thinking (Box 1) and is multidisciplinary, and increasingly transdisciplinary, with reliance on social sciences, economics, anthropology, ecology, information and communication sciences, and biosciences. Research includes descriptive, comparative, evaluation and secondary analytical research, as well as experimental studies which are less common but can be very useful (Remme et al. 2010).

Stakeholders of systems strengthening research relevant to this report are vast and diverse. Stakeholders include smallholders and their communities; and public, private and civil society organisations and networks operating in the health, agricultural, environment, land development, economic development and community development sectors, at the community, provincial, national, and international level.

Box 1.1 - Systems strengthening can be usefully grounded in systems thinking

Adapted from Kay (2008)

Systems thinking emphasises connectedness, context, and feedback within defined systems.

The parts of a system can only be understood from the organisation of the whole. Understanding comes from looking at how the parts operate together rather than from teasing them apart.

Systems thinking provides guidance about how to decide what is important and not important to look at, and how to describe a situation and map out possible future scenarios and trade-offs.

Diverse perspectives need to be understood because linear causal relationships are inadequate for explaining the dynamics of the system.

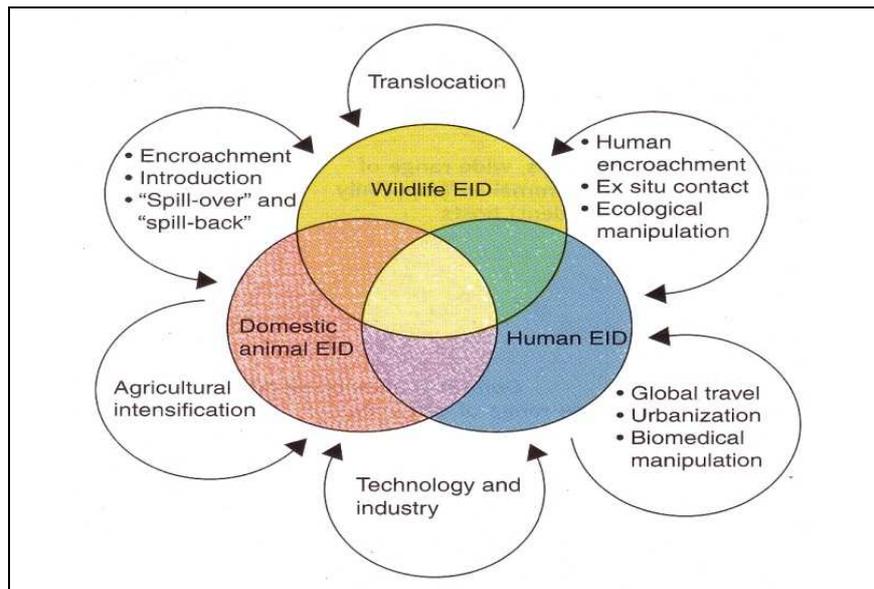
Systems thinking is particularly applicable in contexts where simple prediction fails and there is intrinsic uncertainty, where values are in conflict, and when the stakes are high and there is a sense of urgency.

Research questions identify and explain interactions, relationships and patterns.

3 Socio-ecological systems research and applications

Zoonoses exist as part of complex social and ecological systems. Complex systems contribute to the persistence of neglected zoonotic diseases (NZDs) in communities, and to emerging infectious diseases (EIDs), the majority of which are zoonoses (Figure 1).

Figure 1 - Emerging infectious diseases are a consequence of complex socio-ecological systems (from Daszak et al. 2000)



Socio-ecological systems refer to 'bio-geo-physical' units and their associated social actors and institutions. The goals and objectives for socio-ecological systems strengthening relate to how social and ecological problems are framed, and how they are addressed to meet society's development objectives (e.g. see Box 3).

Global stakeholders for socio-ecological systems strengthening relevant to poverty alleviation, zoonoses and smallholder livestock systems include:

1. Canada's International Development Research Centre (IDRC),
2. EcoHealth Alliance,
3. EcoHealth International Association for Ecology and Health, and
4. Millenium Ecosystem Assessment.

Box 1.2 - Socio-ecological systems thinking

Adapted from Kay (2008)

"The distinction between social systems and ecological systems, and the linking of them into socio-ecological systems, is a useful simplification for teasing apart difficult problems," (Waltner-Toews et al., p. ix).

Socio-ecological systems thinking seeks to extend traditional ecosystem and social science (which is interdisciplinary and participatory), by developing complex systems approaches to enquiry and development that are transdisciplinary, with emergence between disciplines rather than working between them. Approaches are generally participatory, adaptive and multi-scale (Kay, p. 11).

Box 1.3 - Example of problem framing: zoonotic disease transmission through livestock and wildlife interaction

A recent report to the UK DFID by ILRI and the Royal Veterinary College, London (Jones et al. 2011) synthesizes scientific knowledge about zoonotic disease transmission through livestock and wildlife interaction, with emphasis on risk factors, drivers, transmission trajectories, and promising interventions for disease control. The report addresses the following questions pertinent to socio-ecological systems:

1. What is the extent of the problem of zoonoses, the context and the relative importance of the wildlife/domestic livestock transmission route?
2. Which wildlife species have been implicated in the transfer of disease from livestock to humans and what are the key factors that influence the risk of transmission?
3. What are the main drivers (global and generic within regions) changing the degree of interaction between wildlife and domestic livestock and what are the key characteristics (e.g. geographic, political, economic, demographic, gender etc) which they affect in influencing the risk of transmission?
4. What are the possible interventions (and associated governance structure) that could limit the interaction of key wildlife species with domestic livestock and the potential economic and social impacts (at both state and household level) of those interventions?

The authors' conclude that a major deficit in current management of zoonoses with a livestock-wildlife interface is that programmes are not based on adequate epidemiological or socio-economic understanding.

The authors' identify the following researchable issues:¹

- Lack of evidence on the multiple burdens of zoonotic disease. The authors state, "Many important zoonoses are missing from the WHO Global Disease Burden which is now the lead metric for guiding human health interventions; in addition complementary metrics are needed to capture economic, social and environmental burdens of disease" (p 5).
- Lack of systematic surveillance data.
- Lack of evidence on putative transmission hotspots (e.g. livestock markets, wildlife value chains).
- Limited understanding of rapidly changing institutional environments and rule breaking behaviour (e.g. with reference to food security) and impacts on zoonotic disease risks.

Box 1.4 - Lessons learned from a scoping study on ecosystem approaches for managing zoonoses and emerging infectious diseases: key researchable issues from a country perspective

A 2010 scoping study of ecosystem approaches for managing zoonoses and emerging infectious diseases (ZEIDs) in Cambodia, Laos and Vietnam, from the perspectives of the key stakeholders in these countries, highlighted a priority need as **research evidence to support wider acceptance at the local and country level of the importance of ZEIDS and public control measures, and for prioritizing diseases** (Gilbert, 2010).

The study identified that research should:

- involve collaboration between the relevant stakeholders, and transdisciplinary approaches
- include rural and remote areas
- be integrated with information campaigns and communication strategies
- support skills development, and particularly in risk analysis and information synthesis.

Associated priority research gaps were:

- socio-economic analysis and studies of disease trends, risks and burden
- epidemiology incorporating qualitative and economic methods and molecular epidemiology
- understanding of disease awareness in communities for targeting information campaigns
- how interdisciplinary research can be translated into sustainable actions at a country/regional level.

The study identified that actors in the livestock sector were important ‘boundary-spanning’ partners with linkages to human health and rural development. There were limited or non-existent linkages with environmental health and wildlife diseases. The reviewers reported that Vietnam, Cambodia and Laos have national plans for ZEIDS however the focus is almost entirely avian influenza and more recently rabies. The most frequently cited ZEIDS were avian influenza, rabies, leptospirosis, dengue fever, anthrax and brucellosis.

A report on the scoping study identified from an ecohealth perspective that “human health is weakly integrated with socioeconomics, linkages to policy are stronger than to communities, participation occurs mainly at lower levels, and equity considerations are not fully considered. However, stakeholders have awareness of ecological and social determinants of health, and a basis exists on which transdisciplinarity, equity, and participation can be strengthened” (Grace et.al. 2010).

Examples of initiatives, tools and resources for socio-ecological systems strengthening

Details of the initiatives, tools and resources listed below are available from the organisation websites.

Canada’s International Development Research Centre (IDRC)

- Asian partnership for Avian Influenza Research: effectiveness of control measures
- Ecohealth Emerging Infectious Diseases Research Initiative (see also <http://www.ilri.org/EcoZd>)
- *Ecohealth research in practice: innovative applications of an ecosystem approach to health* (Charron ed. 2012)
- Environmental change, livelihoods and disease emergence in South Asia
- Meeting the challenge of zoonotic emerging infectious diseases in Southeast Asia
- Prediction and prevention of emerging zoonotic diseases in wildlife

EcoHealth Alliance

- Assessing the impacts of global wildlife trade
- Consortium for Conservation Medicine
- EcoHealthNet
- Emerging disease hotspots
- One Health Alliance of South Asia (OHASA)
- PREDICT Program
- Zoonotic Emergence Network (ZEN) in Malaysia and China

EcoHealth: International Association for Ecology and Health Ecohealth conference

- Ecohealth journal

Millenium Ecosystem Assessment.

- *Ecosystems and human well-being: a framework for assessment*
- Global and multiscale assessment reports
- Graphic resources – figures, tables, maps and data
- Synthesis reports

4 Social and cultural factors and systems strengthening

Social and cultural concepts apply to all aspects of zoonoses prevention and control, and including to:

- Justify and evaluate investment in policy and program development.
- Understand the risks and impacts of zoonoses.
- Develop more appropriate and acceptable response and communication tools and mechanisms.

Social and cultural concepts also apply at all scales - individual, household, village / community, national, regional and international level.

Concepts include understandings of adaptive capacity, social learning, self organisation, agency, social capital, networks, sense-of-place, values, social identity and power relationships. There is growing interest in how these concepts can be applied to resilience thinking and studies to improve community resilience (Berkes 2003, Magis 2010).

Risk management and communication

Box 1.5 - Example of the importance of social and cultural factors for managing disease risks

Rushton et al. (2012), note that people's behaviour dictates how a disease enters a society, how it spreads and how it is controlled.

Accordingly risk management in livestock value chains requires people centred approaches and this further requires deep knowledge of economic incentives, the institutional environment (including official and informal rules and their enforcement), and social, cultural and psychological factors.

Factors influencing risk behaviours need to be understood:

- at the individual level (including physical attributes such as gender and age, personal characteristics such as general beliefs about risk-taking, and resource base and livelihood options); and
- at the group level (including consideration of family and social networks, cultural practices, economic drivers, official rule structures, the political environment and the availability of information).

Armed with deep knowledge, interventions can be developed at effective 'entry points' in an institutional environment, and which accommodate peoples' behaviour and the causes of 'rule breaking' within that environment, to improve risk management.

Examples of researchable issues

- Understanding human animal interactions in smallholders systems and how they relate to social, environmental and economic change.
- Managing social processes of disease transmission.
- Understanding and more effectively managing social issues around interpretation, information and communication.
- Understanding and more effectively mobilising community resources.
- Understanding the social and economic costs and benefits of diseases and disease interventions.

Box 1.6 - Examples of research on social and cultural factors to guide responses to HPAI

Importance of involving all stakeholders in the development of communication strategies

Alders and Bagnol (2007) review the challenges of developing effective communication materials and methodologies for the prevention and control of HPAI in diverse settings with multiple stakeholders. The authors highlight the importance of professional assistance and adequate resourcing and time for managing education and communication (EC) activities, and the opportunity afforded by HPAI to extend the communication capacity of animal services and peoples' life skills to the prevention and control of other diseases. The authors identify the following lessons learned regarding message preparation and delivery:

The need to involve all key stakeholders in EC working groups including family poultry farmer associations.

Messages should be credible with respect to the social, cultural and economic realities of target audiences.

EC materials need pre-testing for the entire range of situations in which they will be used.

Messages should be balanced and informative and not incite panic.

Compensation post culling requires good communication to ensure peoples' cooperation.

Different methodologies are required for different circumstances.

Benjamin Hickler in his study, *Bridging the Gap between HPAI awareness and practice in Cambodia (2007)*, highlights that while technical rationales are "great for identifying practices to promote, discourage, or target through communication strategies, they will never be able to convince anyone why, from their point of view, it makes sense to do things differently – i.e., a local rationale". Messages need to connect with local values and priorities. "For the smallholder farmer in rural Cambodia, values like *the sake of humanity of civic responsibility* are not going to get much local traction". The study identifies *family prosperity and well-being* as the key for linking priority messages to a value which will more likely lead to behaviour change.

Importance of understanding and addressing gender aspects of disease prevention and control

Velasco et al. (2008) in their report, *Gender aspects of the avian influenza crisis in Southeast Asia*, identify that national plans, programs and guidelines for avian influenza (AI) do not address gender issues and this is a major gap considering that women are major players in backyard poultry production, rural and agricultural economy, and in the prevention and control of avian influenza. The authors outline a comprehensive program for research on gender relating to socioeconomic impacts of AI, effectiveness of communication campaigns and information needs, and the impacts of national policies and including the potential for likelihood displacement for poor rural women associated with "government's preference for a more bio-secured and predominantly male-managed market-orientated poultry". The authors call for competence development on gender for people who develop and implement AI programs, and for gender considerations to be integrated into communication and training programs, program evaluation and measuring social and economic impacts of AI.

Examples of initiatives, tools and resources that address social and cultural factors

- Integrated Control of Neglected Zoonoses (ICONZ), and particularly:
 - Work Packages 5-8: Integrated intervention packages for clusters of zoonotic diseases
 - Work Package 9: Economic and institutional aspects
 - Work Package 10: Cultural aspects, gender issues, traditional knowledge and messaging
 - Work Package 12: Communication and dissemination
- International Rural Poultry Centre, KYEEMA Foundation, Australia
- UNICEF communication strategies for avian influenza
- USAID PREVENT

5 Governance and resourcing for systems strengthening

Governance and resourcing are critical considerations for systems strengthening. Current drivers for strengthening governance, along with examples of key initiatives, are in Box 1.

A critical barrier for strengthening governance and resourcing for the prevention and control of NZD's and EIDs is limited published evidence or evaluation of the:

- costs and burden of zoonotic diseases,
- benefits of disease prevention and control programs and associated investments, and the
- lessons learned from program/initiative successes and failures.

Creating the database that accompanies this report highlighted the limited number of published studies on this topic, although many reports identify the issue. Examples of reviews that discuss the prioritization of zoonoses, with reference to economic costs, global burden of disease, expert opinion, and/or multiple perspectives (e.g. moral, human rights, economic and global goods perspectives) include WHO 2012, Jones et al. 2012, Perkins et al. 2007 and Perry et al. 2002.

A further challenge for governance and resourcing programs is the need to understand and balance complex relationships among public, private and civil society stakeholders. For example there are pushes in many countries to privatise the cost of control programs for endemic diseases of livestock, with vigorous debate about the flow of public and private benefits across livestock value chains and who should pay. International development organisations such as FAO and the IDRC promote animal health services in developing countries as an essential global public good and therefore dependent upon ongoing donor and government investment. Balancing the governance and resourcing priorities of international, national and sub-national organisations is a major part of the challenge to better manage zoonoses in developing countries.

A third major challenge for governance and resourcing and systems strengthening is managing across sectors to achieve health and development objectives for poverty alleviation, zoonoses and smallholder livestock systems. This topic is picked up in the following section on One Health.

Governance and resourcing issues are further addressed in the following chapters and case studies.

6 'One Health' movement and systems strengthening

One Health (OH) has been described as a concept that became an approach and then a movement (OH Global Network 2012). One Health has various definitions that refer to integrated approaches to health that focus on the interactions between animals, humans and their environments. One Health promotes collaborations, synergies and cross-fertilisation among all professional sectors and actors whose activities may have an impact on health (European Union 2012).

The OH movement can be traced back to the establishment of the Manhattan Principles on 'One World One Health' (Wildlife Conservation Society 2004). One Health approaches are now recognised by international organisations including United Nations organisations (WHO, FAO, OIE, UNSIC), The World Bank, European Union and APEC.

There is broad recognition that OH concepts require testing through systematic, practical applications at a country level. This is happening, albeit at early stages of implementation, in many countries.

Box 1.7 - Key findings of a review of OH initiatives in Europe and Asia

A review by Hall and Coghlan (2011) of OH and its application has documented more than 90 OH initiatives in Asia and Europe, more than 750 focal points for contact information for OH actors and practitioners in Asia and Europe, and 250 documents from peer reviewed and grey literature that reference OH.

The review produced the following key findings from an analysis of ten case studies of OH:

- Themes considered important to all case studies were **transdisciplinarity, prevention of disease, zoonoses, complexity, and community level responses**.
- Themes considered important to a few of the case studies were improved risk management, education / in-service training, community participation, preparedness and planning.
- Least addressed themes were involvement of the wildlife / environment sector, barriers to uptake or adoption of OH approaches, involvement of the private sector, regional networks, roles of main players, funding, and communications.
- Many of the case studies lacked substantive input to policy formulation, even where project activities led to successful completion of outputs.

The reviewers further identified the following issues and challenges for OH:

- the need to refine what could constitute necessary (but not necessarily sufficient) elements of OH
- lack of knowledge about the drivers required for disciplines to work better together, other than through top-down directives,
- OH benefits are not identified as institutional priorities, but are rather viewed as positive externalities
- efficient operationalisation of OH is a barrier to its implementation
- there are limited examples and evidence of OH outputs, impacts and benefits to drive action.

Examples of researchable issues

Examples include cross sector and multidisciplinary approaches for:

- Undertaking risk assessments, and assessing and prioritizing diseases and actions.
- Establishing clear goals, priorities, policy directions, deliverables and practical guidelines for OH action that can be adopted across sectors.
- Establishing and sharing information platforms, improving the quality of surveillance data and creating data sharing arrangements, developing syndromic and event-based surveillance systems, and developing cross-sector laboratory capacity.
- Increasing community awareness and participation in disease prevention and control, e.g. by developing communication networks; developing mechanisms to mobilize resources; developing appropriate OH messaging and including for risk communication; and identifying and sharing success stories of effective communication, education, and disease prevention and control in communities.
- Incorporating OH approaches in vocational, university and field-based training.
- Ensuring resources are sustainably and efficiently applied in implementing OH approaches, e.g. by understanding community, industry and government needs, motivations and incentives for OH action; identifying opportunities to better link responses to overall government priorities and to support resource allocations to give emphasis to disease prevention; developing resource allocation models that allow oversight and leadership for OH approaches; and sharing knowledge and experiences about resource allocation, policy directions and models.

Examples of initiatives, tools and resources for one health approaches:

- ICONZ Integrated Intervention Packages for Clusters of Neglected Zoonoses
- FAO Strategic Action Plan for One Health
- One Health Alliance of South Asia
- One Health Commission
- One Health Global Network web portal
- One Health Initiative
- OneHealthTalk.org
- Predict
- Rift Valley Fever research partnership
- The Global Early Warning System

ANNEX 2: SELECTED EXAMPLES OF PRINCIPLES AND PROGRAMS FOR HEALTH SYSTEMS STRENGTHENING

Box 2.1 - The Declaration of Alma-Ata (1978)

The Declaration affirms the right of people to be able to participate individually and collectively in the planning and implementation of their health care and the fundamental importance of primary health care for enabling people to lead socially and economically productive lives. It cites the prevention and control of locally endemic diseases as a basic requirement for primary health care and affirms that in addition to the health sector, primary health care includes “all related sectors and aspects of national and community development, in particular agriculture, animal husbandry, food, industry, education, housing, public works, communications and other sectors; and demands the coordinated efforts of all those sectors.”

Declaration principles continue to be reaffirmed

Health systems will “not naturally gravitate towards more fair, efficient (those that work better) and effective (those that achieve their goals) models.... All components of society – including those not traditionally involved in health – have to be engaged, including civil society, the private sector, communities and the business sector. Health leaders need to ensure that vulnerable groups have a platform to express their needs and that these pleas are heeded. There is enormous potential to be tapped,” (WHO 2008 World Health Report, *Primary health care: now more than ever*).

Box 2.2 - Examples of WHO programs for health systems strengthening

In 2003 WHO shifted its focus from control measures for specific neglected tropical diseases (NTDs) to the health needs of poor communities. This new approach led to the introduction of preventive chemotherapy via integrated large-scale administration of anthelmintic medicines, and intensified case management. Supporting measures included the control vectors and their intermediate hosts, veterinary public health, water and sanitation, health awareness and education, and capacity building. WHO is advocating for further integration of approaches for preventive chemotherapy, rather than isolated disease-specific interventions.

In 2011 WHO launched an **Implementation Roadmap for NTDs** that includes goals and targets by disease for 2015 or 2020. The roadmap identifies benefits of working at the human-animal interface for responding to neglected zoonotic diseases (NZDs) such as human dog-mediated rabies, cystic and alveolar echinococcosis, fascioliasis and foodborne trematodiasis, porcine cysticercosis, zoonotic trypanosomiasis, and visceral and cutaneous forms of zoonotic leishmaniasis.

In 2011 WHO also established a **Working Group on NZDs** to focus on surveillance, burden and integrated control measures. Related WHO activities include expanding/initiating strategy validation field studies, building national capacity in disease surveillance and diagnosis, initiating large-scale control in priority countries, and mobilizing resources.

WHO notes that for most NTDs, sustained elimination of zoonoses is possible only with full access to safe water, waste disposal and treatment, basic sanitation and improved living conditions. UN statistics show that 900 million people lack access to safe drinking-water and 2500 million lack access to safe sanitation.

The WHO **Global Outbreak Alert and Response Network (GOARN)** is a technical collaboration for the rapid identification, confirmation and response to outbreaks of international importance.

Box 2.3 - The Bangladesh experience of transcending poverty through health systems strengthening

Koehimoos et al. (2011), in *Health transcends poverty: the Bangladesh experience*, present an analysis of a country which has made considerable, sustained population health gains, beyond what might be expected on the basis of income level. Key messages (p 49):

“Bangladesh became a nation in 1971 under the most difficult circumstances and since then has made huge strides in improving its population’s health. A political commitment to health was enshrined in the 1972 Constitution, and policies have transcended political change while constantly adapting to emerging issues.

Bangladesh was one of the first developing countries to strongly endorse a national family programme, resulting in dramatic reduction in fertility. Bangladesh’s basic population and health indicators are on a par with or better than its neighbours, despite having a lower per capita income.

Bangladesh has continued to be an innovator in health policies and in testing and adapting low cost technologies in the health sector, while maintaining long-term continuity of policies. This is demonstrated by its long history of community and voluntary health workers who bring appropriate technologies to its people.

Innovation has been facilitated by an environment that has created policy space for the non-state sector. Bangladesh’s world renowned non governmental organisations and initiatives in health have grown and matured alongside public sector activities, often working together to deliver services.

Bangladesh’s health achievements have occurred in the context of improved literacy, economic development and some positive changes in the social fabric of the nation.”

Box 2.4 - Examples of OIE and FAO programs for systems strengthening

The **OIE PVS Pathway** is a global programme for the sustainable improvement of a country's Veterinary Services' compliance with OIE international standards. The program goals are to improve animal and public health, and compliance with Sanitary and Phytosanitary Standards (SPS). Program components include (i) human, physical and financial resources, (ii) technical authority and capability, (iii) interaction with stakeholders, and (iv) access to markets.

The **OIE/AusAID Program to Strengthen Veterinary Services in South East Asia (PSVS)** has been developed to enhance the capacity of countries to effectively detect and respond to EIDs. Program components support PVS evaluation and include advocacy, engagement, training and coordination.

World Animal Health Information Database Interface provides access to all data held within **OIE’s World Animal Health Information System**. Data includes information about a country’s animal health status and veterinary services, diseases reports and distribution maps, disease control measures, and sanitary information.

The **OIE South East Asia China Foot and Mouth Disease Campaign**, while having a disease specific focus, has sought to build broader animal health system capacity through the development of regional networks and skills which in turn deliver broader benefits to health systems.

FAO’s **Animal Production and Health Division (AGA)** assists Member countries to develop their livestock systems towards achievement of the Millennium Development Goals, and goals 1 and 7 in particular (eradicate extreme poverty and hunger and ensure environmental sustainability). FAO facilitates the participation of smallholder livestock farmers in developing countries, in the increasingly competitive market for livestock

commodities, among other activities. FAO promotes international cooperation to safeguard the three global public goods most affected by changes in the sector: equity, veterinary public health, and environmental sustainability and the natural resources used in animal production.

FAO's **Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases (EMPRES)** promotes the effective containment and control of the most serious epidemic livestock diseases/Transboundary Animal Diseases (TAD) as well as newly emerging diseases by progressive elimination on a regional and global basis through international co-operation involving Early Warning, Early Reaction, Enabling research, Coordination.

FAO's web-based information systems include the *Global Livestock Production and Health Atlas (GLiPHA)*, an interactive electronic atlas providing a scaleable overview of national and sub-national information, the *Gridded Livestock of the World*, presenting data on livestock and production density maps and the *PAAT Information System* with data on tsetse and trypanosomiasis in sub-Saharan Africa.

Box 2.5 - Challenges of incorporating civil society organisations (CSOs) in African Agricultural Research and Development (Jones and Sanyang 2007)

CSOs such as farmers' organisations (FOs), agri-business and NGOs are important stakeholders in the agricultural sector, yet they have limited involvement in agricultural research and development (R&D).

FOs and small-medium enterprises are unable to provide a coordinated voice at regional, sub-regional and national levels of African agricultural research and development.

Key issues for FO engagement in R&D concern: membership, mobilisation and retention; representation of members and their views particularly at regional and sub-regional levels; governance and communications; difficulties in identifying needs; and strategic planning capacity.

Key issues for agri-business engagement in R&D concern: culture of 'quick gains' and 'busy schedule'; limited interest in research and committing time to 'long' participatory processes; however there is motivation to adopt profitable technologies.

Key issues for engagement of the Sub-Saharan Africa NGO Consortium in R&D concern: institutional capacity and cohesiveness; capacity to implement planned activities; effectiveness of voluntary focal points; governance; communication and information exchange; and the interface with farmer organisations.

The Forum for Agricultural Research in Africa (FARA) has developed guidelines to facilitate engagement of CSOs in agricultural R&D with a focus to on strengthening linkages between CSOs and Sub-regional offices.

ANNEX 3: SELECTED EXAMPLES OF PRINCIPLES AND PROGRAMS FOR SUSTAINABLE MANAGEMENT OF ENDEMIC ZOOSES

Box 3.1 - Integrated Control of Neglected Zoonotic Diseases in Africa – Applying the “One Health” Concept (WHO 2009)

“Endemic zoonotic diseases such as anthrax, bovine tuberculosis, brucellosis, cysticercosis, echinococcosis (hydatid disease), rabies and zoonotic trypanosomiasis (sleeping sickness) occur throughout the African continent where conditions for their maintenance and spread exist. These diseases perpetuate poverty by attacking not only people’s health but also their livelihoods. Unfortunately, these persistent zoonoses remain neglected in most of the African countries where they are endemic because of lack of information and awareness about the extent of the problem, lack of suitable diagnostic and managerial capacity, and lack of appropriate and sustainable strategies for prevention and control. The result is a false perception that the burden of these diseases and their impact on society are low, such that they neither attract the health resources nor the research needed for their control ...

“Control of NZDs, by simultaneously saving lives and securing livelihoods, offers a very real and highly cost-effective opportunity for alleviating poverty, especially in remote rural areas and marginalized peri-urban communities...

“Because NZDs affect both humans and animals, especially where they affect livestock, interventions to control NZDs require concerted action between veterinary, livestock and human health sectors. A comprehensive, interdisciplinary approach is therefore needed to address the major obstacles to control NZDs...

“Successful control of NZDs entails effective leadership and concerted effort as well as technical, financial and political support.”

A report on “Zoonoses and marginalised infectious diseases of poverty: Where do we stand?” (Molyneaux et al. 2011) noted the special difficulties of dealing effectively with zoonoses and that:

“A Disease Reference Group on Zoonoses and Marginalised Infectious Diseases (DRG6) was convened by the Special Programme for Research and Training in Tropical Diseases (TDR), a programme executed by the World Health Organization and co-sponsored by UNICEF, UNDP, the World Bank and WHO. The key considerations included: (a) the general lack of reliable quantitative data on their public health burden; (b) the need to evaluate livestock production losses and their additional impacts on health and poverty; (c) the relevance of cross-sectoral issues essential to designing and implementing public health interventions for zoonotic diseases; and (d) identifying priority areas for research and interventions to harness resources most effectively. Beyond disease specific research issues, a set of common macro-priorities and interventions were identified which, if implemented through a more integrated approach by countries, would have a significant impact on human health of the most marginalised populations characteristically dependent on livestock.”

Box 3.2 Macro Research priorities identified by Disease Reference Group 6 (Molyneaux et al. 2011)

1. There is a need to develop a comprehensive methodology for calculating the societal burden of disease attributable to zoonoses recognising that a high proportion of the population of rural (and often urban) populations in least developed countries depends on livestock.
2. More studies are required to generate data on the costs, cost-benefits and cost effectiveness of interventions for endemic zoonoses. Such studies should also incorporate the economic effect of animal disease as an indirect contributor to poverty through the impact on nutrition, loss of meat and milk products and livestock as a capital asset.
3. There is a need for operational and systems research to identify reasons for the limited communication and interaction between the key sectors - health, agriculture, livestock - particularly in countries where a large proportion of the population is dependent on livestock.
4. There is a need to evaluate effective community-based approaches and interventions for zoonotic disease, drawing on the experience and success of initiatives for water and sanitation improvements, mass drug delivery and community-based health care.
5. Experiences from separate initiatives in different geographic and epidemiological settings need to be evaluated to ensure that such experiences are amplified and synergised, with potential for integration between programmes.
6. Investing in systems for collection of reliable data on disease/infection incidence and prevalence from both veterinary and medical sectors is recognised as a priority, both for measurement of disease burden and for evaluation of control measures.
7. Investment in endemic zoonoses in least-developed countries would provide multiple benefits, not only improving health and livelihoods of marginalized communities, but also reducing threats and enhancing response capacity for emerging zoonoses that pose a threat to the global community.
8. Effective lessons are often best learned by implementation of strategies (such as the onchocerciasis control program), with research to evaluate factors leading to success measured by effectiveness and cost-effectiveness embedded within programme implementation.
9. As endemic zoonoses disproportionately affect impoverished and marginalised populations, investments need to be specifically targeted to overcome barriers to health care in these communities, including isolation, population movement or migration, social or political unrest, and conflict.

Box 3.3 - Research-based approaches to brucellosis control in four countries

In the USA, a major regulatory review of the long-standing bovine tuberculosis and brucellosis control program has been undertaken which takes into account the existence of wildlife reservoirs (bison and elk) and the current impossibility of complete eradication. An extensive consultation program (e.g. Thomas 2011) explained the implications for cattle producers, wildlife managers and their clients, including details such as how indemnity for reactor cattle will be determined. Clear, specific and practical communication on this and other measures which have been validated by all parties are essential for ongoing cooperation by owners and fair administration by operational staff. Likewise a legal framework and communication strategy which takes into account all legal parties (States and Tribes in the USA) is essential.

In Mongolia, a prospective cost benefit analysis of control of both *Br. abortus* and *Br. melitensis* by vaccination of cattle, sheep and goats (Roth et al. 2003) found that “Mass vaccination of livestock against brucellosis in Mongolia would be cost effective and would result in net economic benefit if interventions costs were shared between the different beneficiaries on the basis of an intersectoral economic assessment. The presented trans-sectoral analysis is applicable to other zoonoses and environmental threats to public health and contributes to the perception that interventions in the livestock sector can control disease transmission to humans”.

In India, 80% of the population live in approximately 575,000 villages and thousands of small towns and have close occupational contact with domestic and / or wild animal populations, and live in conditions conducive for widespread human zoonotic infection on account of unhygienic conditions and poverty. Human brucellosis prevalence appears to be increasing, perhaps due to increased trade and rapid movement of livestock (Renukaradhya et al. 2002). They described an innovative, culturally appropriate approach targeted to overcome the basic problems of bans on cow slaughter, distress sale of animals following the positive serological diagnosis of brucellosis and absence of a disease control strategy. This plan engages village milk cooperatives and focuses on village level testing of milk and five-year follow up calf vaccination in infected villages, as well as testing of bulls destined for artificial insemination centres.

In Uganda, Makita et al. (2010) considered the human health aspect, and tried to identify policy options for risk-based mitigation strategies to reduce human brucellosis infection through consumption of informally marketed raw milk potentially infected with *Brucella abortus* in Kampala. They found that “12.6% of informally marketed milk in urban Kampala was contaminated with *B.abortus* at purchase and the annual (*human brucellosis*) incidence rate was estimated to be 5.8 per 10,000 people. The best control option would be the construction of a milk boiling centre.... and to ensure that milk traders always sell milk to the boiling centre”. expected that this would also reduce tuberculosis spread by milk.

Parasitic zoonoses are usually associated with poverty and ignorance (Willingham 2002), who adds:-

“As parasitic zoonoses are considered to pose a serious constraint to human/agricultural/ economic development, food security and safety, human health and well-being, and environmental sustainability in endemic rural communities, much more attention is needed to increase awareness of their presence and impact....” Effective and reliable tools for the diagnosis, prevention and control of parasitic zoonoses are now available, though the techniques/technology for such have yet to be transferred to a significant degree to the endemic country researchers and control authorities. A more crucial need at this time is baseline information on the epidemiology and socio-economic impact of these diseases and on the need and cost-effectiveness of intervention before these tools can be appropriately utilised. There is also a need to describe and understand how stakeholders, politicians, decision-makers, public health and agricultural

authorities and the affected communities perceive parasitic zoonoses. Such information is essential to identify appropriate priorities and to ensure the longterm political and community support needed to control these diseases. As parasitic zoonoses are often related to poor, weak or nonexistent veterinary public health infrastructures, attention should also be given to operational research related to ensuring safe livestock rearing and slaughter practices, comprehensive meat inspection programs and effective meat processing procedures.”

Long term approaches are needed as shown in Box 3.4.

Box 3.4 - Sustained, supervised, community-based strategy for vector control and management of Chagas disease in the Gran Chaco, Argentina (Gürtler et al. 2007)

“Chagas disease remains a serious obstacle to health and economic development in Latin America, especially for the rural poor. We report the long-term effects of interventions in rural villages in northern Argentina during 1984–2006. Two community-wide campaigns of residual insecticide spraying immediately and strongly reduced domestic infestation and infection with *Trypanosoma cruzi* in *Triatoma infestans* bugs and dogs and more gradually reduced the seroprevalence of children <15 years of age. Because no effective surveillance and control actions followed the first campaign in 1985, transmission resurged in 2–3 years. Renewed interventions in 1992 followed by sustained, supervised, community-based vector control largely suppressed the reestablishment of domestic bug colonies and finally led to the interruption of local human *T. cruzi* transmission. Human incidence of infection was nearly an order of magnitude higher in peripheral rural areas under pulsed, unsupervised, community-based interventions, where human transmission became apparent in 2000. The sustained, supervised, community-based strategy nearly interrupted domestic transmission to dogs but did not eliminate *T. infestans* despite the absence of pyrethroid-insecticide resistance. *T. infestans* persisted in part because of the lack of major changes in housing construction and quality. Sustained community participation grew out of establishing a trusted relationship with the affected communities and the local schools. The process included health promotion and community mobilization, motivation, and supervision in close cooperation with locally nominated leaders.”

Box 3.5 - Sustainable control of zoonotic pathogens in wildlife: how to be fair to wild animals?

Artois et al. (2011) noted that “Wildlife may harbour infectious pathogens that are of zoonotic concern. However, culling such reservoir populations to mitigate or control the transmission of these pathogens to humans has proved disappointingly inefficient.” There may be also conservation reasons for not culling wildlife, and in some cases cultural objections. They also noted alternatives to culling:

“are still in an experimental stage of development. They include vaccination, medication, contraception and environmental manipulation, including fencing and biosecurity measures. This review examines the general concepts involved in the control of wildlife diseases and presents relevant case studies. Since wildlife disease control inevitably involves interfering with wildlife ecology, this is a complex goal whose attempts at realisation should be supervised by a scientific organisation. Most approaches within natural ecosystems should first be carefully tested in trials that are progressively extended to a larger scale. Finally, all measures that aim to prevent infection in humans (such as personal hygiene or vaccination) or that encourage us to avoid infectious contacts with wildlife should be recommended.”

Capacity building is critical at both the community and professional level. For example:-

In Mexico the field trials of an educational intervention against *T. solium* based on careful ethnographic study and extensive community participation proved successful in reducing the rate of transmission within 6 months, as evidenced by decreased infection prevalence in young pigs (Sarti et al. 1997).

In India, Kakkar et al. (2011) assessed the knowledge of zoonoses among medical students and recent graduates in India, to understand critical gaps in medical education with respect to zoonoses. They found that:

“Out of the 364 respondents, only 10 defined zoonoses accurately (2.8%). Only 33.7% of the respondents in the public college (62 out of 184) and 3.3% in the private college (6 out of 180) could correctly name three common parasitic zoonoses in India. Only 5.5% of respondents (20 out of 361) were able to identify rabies as a disease transmitted by animals other than dogs. Knowledge on all emerging and new infectious diseases was poor. The average knowledge score was 64% in the public medical college and 41.4% in the private medical college. These poor scores imply that, on average, a student knows only 40–60% of what is needed to diagnose, treat and report zoonotic diseases effectively. Considering the changing landscape of infectious diseases, the current medical curriculum needs to be revised to improve understanding of existing zoonoses and also include emerging diseases.”

Box 3.6 - Strengthening capacity to control neglected tropical diseases (WHO 2012)

WHO is developing a framework for capacity building at the national level that could extend this expertise to the peripheral level, including:

- assessing the national human resources needed to implement control strategies;
- strengthening national capacity for monitoring and evaluation as well as for research to support evidence-based decision-making for NTD control;
- developing standardized training materials, including materials for community health workers and non-formal care providers, and translating them into local languages based on needs;
- creating in-service training for national NTD and vector control programme managers as well as for prevention of blindness coordinators;
- developing in-service training for health workers involved in implementing control strategies, such as physicians, nurses, laboratory technicians, data managers, vector control staff, veterinary public health workers, epidemiologists and staff of mobile teams;
- collaborating with WHO regions and Member States to develop training materials for community health workers and non-formal care providers;
- working with training institutions to enhance their training capacity;
- consolidating and developing networks to expand dissemination of knowledge and skills to sufficient numbers of health workers in all categories involved in NTD control.

Tools and curricula will be based on training needs and assessments to guarantee continuous learning and the dissemination of newly acquired skills and knowledge. Volunteers, community leaders and front-line health workers are the backbone of public-health delivery systems and disease surveillance; control of these diseases must therefore involve their active participation.

Health workers perform numerous key tasks, including diagnosis, reporting and responding to many health issues. If not adequately trained to apply public-health standards and protocols, frontline health workers will not inspire public trust and confidence, and entire disease control programmes may be jeopardized.

ANNEX 4: SELECTED EXAMPLES OF PRINCIPLES AND PROGRAMS FOR MANAGEMENT OF ZOOONOTIC EMERGENCIES

Box 4.1 - Disaster Risk Reduction through the Hyogo Framework for Action 2005 – 2015

Strategic goals

(a) The more effective integration of disaster risk considerations into sustainable development policies, planning and programming at all levels, with a special emphasis on disaster prevention, mitigation, preparedness and vulnerability reduction.

(b) The development and strengthening of institutions, mechanisms and capacities at all levels, in particular at the community level, that can systematically contribute to building resilience to hazards.

(c) The systematic incorporation of risk reduction approaches into the design and implementation of emergency preparedness, response and recovery programmes in the reconstruction of affected communities.

Specific gaps and challenges from past actions were identified in the following five main areas:

(a) Governance: organizational, legal and policy frameworks.

(b) Risk identification, assessment, monitoring and early warning.

(c) Knowledge management and education.

(d) Reducing underlying risk factors.

(e) Preparedness for effective response and recovery.

Priorities for action

1. Ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation.

2. Identify, assess and monitor disaster risks and enhance early warning.

3. Use knowledge, innovation and education to build a culture of safety and resilience at all levels.

4. Reduce the underlying risk factors.

5. Strengthen disaster preparedness for effective response at all levels.

Box 4.2 - EXAMPLES FROM RELEVANT SECTORAL EMERGENCY RESPONSE FRAMEWORKS

A. Steps in FAO/WHO framework for developing national food safety emergency response plans (FAO 2010)

Step 1. Obtain high-level support and mandate from appropriate government agencies to develop a multi-agency response plan.

Step 2. Identify key partners, possibly involving:

- food inspection services; veterinary services; public health and epidemiology services; laboratory services; agriculture; emergency response services/specialists; customs and quarantine; legal services; law enforcement; food science and technology (government); media and communications;
- other relevant sectors.

Step 3. Establish a planning group to lead the process of developing the food safety emergency response plan.

B. WHO STRATEGY ON HEALTH SECTOR RISK REDUCTION AND EMERGENCY PREPAREDNESS (WHO 2007)

WHO aims to help nations to increase capacity for health sector risk reduction and emergency preparedness, noting that “*Risk is a function of the hazards to which a community is exposed and the vulnerabilities of that community. However, that risk is modified by the level of the local preparedness of the community at risk*”.

Guiding principles

Overriding principle: risk reduction and emergency preparedness are the responsibility of all sectors at all levels

- *Risk reduction and emergency preparedness are part of the development process.*
- *An all-hazard approach is essential.*
- *Risk reduction and emergency preparedness are the responsibility of all national actors.*
- *Emergency preparedness requires a multisectoral approach.*
- *Priority on technical assistance*

Box 4.3 - SOME EXAMPLES OF EFFECTIVE NATIONAL EMERGENCY PREPAREDNESS AND RESPONSE FRAMEWORKS

Australia's Emergency Animal Diseases Response Agreement (EADRA) provides a legal basis for federal and state governments and livestock industries to implement cost sharing and management of emergency animal diseases, including several significant zoonoses. It contains details of joint decision making processes for activation of plans, emergency funding, and response and recovery implementation. This is supported by AUSVETPLAN, a comprehensive set of technical plans, policies and procedures which are regularly updated. AUSVETPLAN is maintained by Animal Health Australia, a not-for-profit company with government and industry members, which conducts or manages revisions and training as well as facilitating negotiations on changes. Relevant Inter-agency and industry – government coordination arrangements are built into different disease strategies and general emergency response policies and procedures.

<http://www.animalhealthaustralia.com.au/programs/emergency-animal-disease-preparedness/>

In the USA, overall response planning rests with the Department of Homeland Security. Their National Response Plan is at http://www.dhs.gov/xlibrary/assets/NRP_Brochure.pdf Anelli (2006) gives the history of the development of the National Incident Management System, and Kim et al. (2007) provide guidelines to the development of an efficient critical incident management system. The National Centre for Animal Health Emergency Management within the Department of Agriculture manages agricultural emergencies. http://www.aphis.usda.gov/animal_health/emergency_management/ This system appears to have been the basic tool for the national planning effort adopted by Homeland Security.

In Canada, the Minister of Public Safety is responsible for promoting and coordinating emergency management plans, and for coordinating the Government of Canada's response to an emergency, pursuant to the *Emergency Preparedness Act* and the *Emergency Management Act*. <http://www.publicsafety.gc.ca/prg/em/ferp-eng.aspx#a3>. All federal ministers are responsible for developing emergency management plans in relation to risks in their areas of accountability. Individual departmental activities and plans that directly or indirectly support the Federal Emergency Response Plan (January 2011) strategic objectives contribute to the integrated Government of Canada response.

The Federal Emergency Response Management System (FERMS) is a comprehensive management

system which integrates the Government of Canada's response to emergencies. It is based on the tenets of the Incident Command System and the Treasury Board Secretariat's Integrated Risk Management Framework.

The Canadian Food Inspection Agency (CFIA) is the lead authority for the monitoring, control and eradication of foreign animal diseases (FAD) in Canada. CFIA has developed strategies to deal appropriately with foreign animal diseases that could be introduced into Canada. These strategies include the science available for foreign animal disease, organized procedures, structures and resource management that lead to early detection of disease or infection, prediction of the likely spread, containment, targeted control and elimination with subsequent re-establishment of verifiable freedom from infection in accordance with the Animal Health Code administered by the Office International des Epizooties (OIE). <http://www.inspection.gc.ca/eng/1297964599443/1297965645317>.

The Office of the Auditor General of Canada reviewed the effectiveness of the emergency plans in 2010 http://www.oag-bvg.gc.ca/internet/English/parl_oag_201010_09_e_34292.html.

The Canadian Animal Health Coalition is a not for profit organization serving Canada's farmed animal industry. The organization, promoting a collaborative approach to animal health, is a partnership of organizations all recognizing a shared responsibility for an effective Canadian animal health system. <http://www.animalhealth.ca/Default.aspx>.

Box 4.4 - Examples of South-East Asian and African arrangements for emergency zoonoses management

South East Asian websites

Singapore. The Agrifood and Veterinary Authority AVA. <http://www.ava.gov.sg/> has a comprehensive website with links to animal and plant health and HPAI (but not other zoonotic diseases) control or preparedness.

Malaysia. The Institute of Medical Research <http://www.imr.gov.my/> is responsible for zoonotic disease surveillance and reports on a wide range of zoonoses The Department of Veterinary Services is responsible for animal disease surveillance and the animal health systems. There is a link to hospitals on their webpage.

<http://www.malaysia.gov.my/EN/Relevant%20Topics/IndustryInMalaysia/Business/AgricultureAndAgroBasedIndustry/AgroLicensePermit/LicenseAnimalServiceDept/Pages/LicenseAnimalServiceDept.aspx> Following the Nipah virus outbreaks, an Inter-Ministry Committee for the Control of Zoonotic Diseases was formed with links to both human and veterinary health. This committee is responsible for planning for infectious disease control and has developed an Infectious Disease Outbreak Rapid Response Manual with predetermined Rapid Response Teams. <http://jknn.moh.gov.my/doc/cdc/Infectious%20Diseases%20Outbreak-Rapid%20Response%20Manual.pdf>

Thailand appears to have vertical systems addressing only one disease rather than a more efficient generic approach for multi-disease incursions. Responsibility for zoonotic disease control and planning rests with the Ministry of Public Health <http://eng.moph.go.th/> HPAI preparedness and reporting but their website does not link to Ministry of Health or Ministry of Agriculture, The Ministry of Agriculture

http://eng.moac.go.th/ewt_news.php?nid=10 and its Department of Livestock Development

<http://www.dld.go.th/webenglish/history.html> are responsible for the animal health system. The Law of Animal Epidemics gives powers for epidemic disease

control. <http://www.thailawforum.com/database1/animal-epidemic-act.html>

Laos. Ministry of Public Health and Ministry of Agriculture and Forestry in cooperation with World Health Organization in Laos held a workshop of National Zoonotic Disease Co-ordination Mechanism for the Health and Animal Sectors in Vientiane on 2 August 2011 <http://laovoices.com/laos-discusses-zoonotic-disease-co-ordination-mechanism/>. "Both Ministries of Health and Agriculture and forestry colleagues have developed the Zoonosis Coordination Mechanism together and agree that a key to working together is through a functional

coordination mechanism in the Lao PDR." This is through the National EID Coordination Office.

Philippines. In April 2011 a Philippine Inter- Agency Committee on Zoonoses was formed by decree <http://elibrary.judiciary.gov.ph/index10.php?doctype=Administrative%20Orders&docid=13267651001687696250> comprising Department of Health, Department of Agriculture and Department of Environment and Natural Resources.

Vietnam: their coordination website is: <http://www.avianinfluenza.org.vn/>

Cambodia has an Inter-Ministerial Cooperation Plan which sits under the national committee for disaster management (NCDM) see

http://www.rccdm.net/index.php?option=com_docman&task=doc_view&gid=123&Itemid=215 and mentions both the MOH and minister of fisheries and forestry plan.

Indonesia: A national commission on zoonosis (KOMNAS Zoonosis) is under the coordinating ministry of social welfare with links to Health and Agriculture ministries, and derives from the former national commission on HPAI

<http://www.menkokesra.go.id/node/145>

African websites

African Field Epidemiology Network (AFENET) <http://www.afenet.net/new/index.php> was formed in 2005 to strengthen field epidemiology and public health laboratory capacity and to contribute to the management of epidemics and major public health problems. It now has 19 member countries and is embracing One Health concepts. It seems to be the major coordinating structure between countries in sub-Saharan Africa for the preventing and control of epidemics and other public health priorities. Countries also have multi representation allowing collaboration between human and animal health within a country. Programs appear to be disease specific rather than developing relationships between organisations on a more generic basis. Their 2010 report is a good summation of activity. http://www.afenet.net/new/images/stories/publications/annual_report_2010.pdf

East Africa: EAC plans to develop a Regional Viral Hemorrhagic Fevers Strategic Emergency Preparedness and Contingency Plan: 2012-2016.

The proposed Contingency Plan seeks to, among others, raise the regional capacity to respond to the VHFs and other emerging and re-emerging diseases of epidemic and pandemic potential in East Africa. In accordance with Article 118 (a) of the EAC Treaty, the Partner States undertook to co-operate and take joint action towards the prevention and control of communicable and non-communicable diseases and to control pandemics and epidemics of communicable and vector-borne diseases that might endanger the health and welfare of the residents of the Partner States, among others. **EAIDSNet** is a regional collaborative initiative of EAC Partner States' national ministries responsible for human and animal health, including wildlife as well as the national health research and academic institutions in both public and private sectors. <http://www.eac.int>

• **EAIDSNet** is a regional collaborative initiative of EAC Partner States' national ministries responsible for human and animal health, including wildlife as well as the national health research and academic institutions in both public and private sectors.

<http://www.eac.int>

Box 4.5 - Research to improve response to anthrax outbreaks in Australia and Indonesia

In Australia – an “anthrax belt” running through western New South Wales has been defined for many years, with sporadic cases annually in a few sheep or cattle, and veterinarians and stock owners generally alert to possible cases, while doctors recognize characteristic carbuncles occasionally in occupationally exposed people. However, in 1997 a major outbreak occurred in a part of northern

Victoria with no previous anthrax history for over a century. As reported by Turner et al (2001), “the scale (83 infected properties) warranted a major response including vaccination of over 78,000 cattle across 600 km² in approximately two months, which rapidly brought the outbreak under control. Subsequent analysis indicated possible weather related causal factors as well as ground disturbance of soil possibly contaminated before the 1890’s.” This experience prompted the later inclusion of anthrax in Australia’s AUSVETPLAN, (see above) moving AUSVETPLAN from a focus not just on “exotic” to also “emergency” animal diseases. Numerous operational policies were also changed in Victoria, especially relating to knackery practices.

In Indonesia, anthrax is endemic in many islands, with a government funded program of annual vaccination of ruminants in known infected areas. However, operational and financial constraints mean that the vaccination programs are often incomplete or untimely in known endemic areas, and may not be implemented at all in some areas of past outbreaks where records have not been kept adequately. Periodic severe anthrax outbreaks occur in various livestock species with human deaths due to consumption of meat from livestock which are slaughtered when sick or even dead. Major outbreaks may develop without community and local health service awareness of the cause of disease and require a joint veterinary / medical team to be sent from Jakarta to distant islands to implement appropriate emergency procedures. Ongoing capture and documentation of information about anthrax incidence and risk factors for its occurrence, as well as community and field staff education, and provision of better livestock slaughtering and meat inspection facilities and practices, are critical to reducing the risks of anthrax into the future. An ACIAR project AH 2006 166 (2008-2012) “Improving veterinary service delivery in a decentralized Indonesia”, among other activities, supported seven local veterinarians from Indonesia’s Eastern Islands to research aspects of the epidemiology, geographic distribution, risk factors for, and costs and benefits of control of anthrax, and the results are being included in a book on Anthrax in Nusa Tenggara which will be available in Indonesian in all Eastern Islands’ district and provincial veterinary and medical facilities for information of staff into the future.

6. CASE STUDIES

6.1 ZONOTIC H5N1 AVIAN INFLUENZA IN INDONESIA

Key messages

- Despite a massive response and investment in the animal health sector, fatal human H5N1 cases continue to occur in Indonesia. The primary risk factor, infection in poultry, has not been successfully addressed.
- A continuing communications effort is needed to educate people at risk of exposure of their risk and can be managed. The difficulties cannot be over estimated. The people at greatest risk are likely to be those for whom the fight against poverty is a daily battle, and for whom more hypothetical risks with a low probability of occurrence are not a primary consideration.
- The experiences with H5N1 in Indonesia reinforce valuable lessons that :
 - Rapid diagnosis and response is critical in the management of disease emergencies.
 - Where disease incursions or emergence are unchecked in situations where the animal and human populations are too numerous, and also not educated, organized and resourced to mount effective responses, infections will become entrenched.
 - Actions that appear attractive because they can be implemented to a certain degree, such as surveillance or vaccination, will be inadequate to make significant impact.
 - Ultimately infectious disease can be controlled only by absolutely breaking the chain of transmission, which will involve full disruption of existing practices along the value chain from producer to consumer for a sufficient period of time to allow infection to be eradicated in each production and marketing compartment.

Background: H5 N1 Avian Influenza emergence in China and its International Spread

H5N1 HPAI came to prominence in 1997 after severe disease occurred in both poultry and humans in Hong Kong. People were infected directly from poultry and the potential for the emergence of a human influenza pandemic with a high case fatality rate was recognized. The outbreak in Hong Kong was controlled through a focussed, aggressive response including the destruction of all commercial poultry in Hong Kong and cessation of trade in live poultry for a 7 week period with accompanying cleaning and disinfection of markets and farms. Changes to the way poultry were reared, transported and marketed, including mandatory enhanced hygiene measures, were introduced (Sims 2011). Hence the chain of transmission of virus was physically disrupted, and measures put in place to ensure that such transmission could not be re-established. Ongoing surveillance for evidence of infection and active public sector monitoring of new management measures ensures ongoing protection from new outbreaks in Hong Kong.

The techniques successful in containing this outbreak are well recognised as control measures for animal disease but have been harder to apply in other countries with larger and more complex poultry production systems and relatively weak (compared with Hong Kong) veterinary services and governance systems (FAO 2011).

Although the H5N1 outbreak in Hong Kong was controlled and the virus eliminated, H5N1 viruses continued to circulate and evolve in mainland China. The steps in this evolutionary process have been tracked and described by Li *et al.* (2004). Primarily through a process of reassortment an H5N1 strain which those authors labelled Z strain had evolved at least by 2002 in southern China. Through routes of transmission that remain undetermined, in late 2003 and early 2004 eight countries (including China) suffered outbreaks of disease

associated with the Z strain of H5N1 HPAI viruses in domestic poultry and some also reported human cases. Japan, the Republic of Korea, Vietnam, Thailand, Indonesia, Cambodia and Lao PDR were all affected.

This strain of H5N1 was introduced into Indonesia during mid-2003 but was not formally reported until February 2004, by which time it was well established and transmitted over a wide area of the country. A massive internationally assisted effort through both the public health and animal health sectors in Indonesia has not succeeded in either eliminating the infection from poultry or preventing its transmission to people (Sims et al (2012). WHO reported late in March 2012 that since 2005 there have been 188 human cases reported in Indonesia of which 156 have been fatal (WHO 2012).

Aims and Objectives:

This case study will note the successes and shortcomings of responses in Indonesia that first led to the infection becoming established in poultry and then becoming endemic. The local measures and the interactions with external agencies that have subsequently had some success but which, in the main, have been overwhelmed by the magnitude of the problem are discussed.

H5N1 Avian Influenza in Indonesia: Early Responses, Endemicity, Management Challenges

FAO has reviewed the circumstances leading to H5N1's becoming endemic, or 'entrenched', in certain countries (FAO 2011) Three factors were identified:

1. the structure of the poultry sector. Endemically infected countries generally have
 - a. complex production and market chains, poorly integrated, with a large demand for locally produced poultry and poultry products
 - b. a high proportion of poultry reared and sold under conditions that afford little protection from influenza viruses
 - c. a significant proportion of poultry do not display clinical signs at the time transmission may occur, such as domestic ducks or poultry transacted relatively quickly in infected markets and collectors yards
2. relatively weak public and private veterinary and animal production services, having limited or no capacity to identify and respond to all cases of infection and not fully understanding the drivers of transmission of infection in value chains. They have been unable to implement needed changes to production and marketing systems.
3. an inadequate level of commitment within the poultry sector, governments and by the public towards the elimination of H5N1 HPAI viruses. The fear of H5N1 HPAI has not translated into determined action for virus control and elimination. Support for the type of measures needed to eliminate H5N1 HPAI will be half-hearted until most farmers regard H5N1 HPAI as a serious threat to their livelihoods and well being. Strong public support is a prerequisite for the elimination of the virus from endemically infected countries.

Delays in initiating control efforts

A review of the early phases of the H5N1 outbreak in poultry in Indonesia by the Directorate General of Livestock Services (DGLS) (Wiyono, 2004) indicated that the first recognized case was in August 2003 in Central Java, with progressive spread to both West and East Java in subsequent months and with widespread infection across the whole island of Java by January 2004. Infection spread to Bali in October 2003 with disease being reported across the whole island by February 2004. The southern parts of the islands of Sumatera and

Kalimantan become infected in November 2003. Nationally it was estimated that by April 2004 7.5 m poultry had died and another 2.75 m depopulated.

However it was not until 2 February 2004 that the disease was formally recognized and reported to OIE. By this time the infection was being actively transmitted in at least 4 for the major islands in Indonesia, islands with a human population in excess of 150 m people. Any prospect of a rapid response to contain the spread of the disease had long disappeared. It is beyond the scope of this case report to speculate as to the causes of the delay, but a lesson would be for countries to be sensitized to the possibility of EID outbreaks. Departments with technical responsibilities, such as in agriculture and public health, must have a clear understanding with the political arms of government as to the absolute value of early diagnosis and reporting, with appropriate political expectation and recognition of the effective delivery on these aspects of disease preparedness.

Adoption of a whole of government approach

Once the outbreak was recognized and human cases were diagnosed the government of Indonesia quickly recognised that an integrated, whole of government approach was needed for coordination of response activities. Human cases were not reported until 2005, with 20 cases leading to 13 deaths recognized that year (WHO 2012).

The National Committee for Avian Influenza Control and Pandemic Influenza Preparedness (KOMNAS FBPI) was formed and operated from 2006 until 2010. Having strong technical and political connections it provided effective communication with the senior levels of the government and provided international agencies with a single focal point for developing national support programs. The usefulness of the committee has been recognized through its being expanded in scope to include other diseases: KOMNAS Zoonosis. In its closing recommendations KOMNAS FBPI also recommended that control of infectious disease outbreaks also be under the supervision of the National Disaster Management Agency (BNPB). Hence important principles were recognized.

Logistical and technical challenges for the animal health sector to respond comprehensively: successes and ongoing issues

As shown by the experiences in Hong Kong cited above, control of infectious disease requires the breaking of the chain of transmission. The veterinary services in Indonesia, in the broadest sense including their relationships with poultry keepers, their operational capacity and their resourcing by government, were unable to comprehensively detect cases, quarantine cases or infected areas, or to stamp out foci of infection. Attempts to develop a system of compensation for poultry owners for birds compulsorily destroyed, to facilitate stamping out, were not convincingly implemented. Funds were inadequate and a “social contract”, that would simultaneously manage suspicions and opportunism and lead to constructive engagement with the poultry owners, was not developed. There was inability in the early years of the outbreak to modify the market chain (a highly traditional, deeply embedded social activity) so potentially infected birds continued to move, potentially spreading infection. It should be appreciated that the Indonesian poultry population is huge. DGSL figures in 2004 were 1.2 billion broilers, 80 million layers, 295 million native chickens and 45 million other poultry (Wiyono, 2004). Managing this number of birds in an essentially unregulated industry has obvious challenges, with enormous resistance to change.

Under these circumstances solutions were sought separately to various aspects of the problem, that could be implemented with the objective of contributing to an improved situation without being the whole solution. Systems for surveillance and improved laboratory diagnosis were established, vaccination introduced and

studies initiated to identify major pathways of transmission of H5N1 in poultry to allow support to be developed for intervention measures in the marketing chain.

i. **Surveillance**

In 2005 a system of disease detection and control at the village level called participatory disease surveillance and response (PDSR) was initiated for trial (Azhar et al 2010). Working at the village level was considered important because of the importance of village poultry in society. The weak links between government and the large commercial sector were not adequately addressed, and this issue remains a weakness. PDSR evolved to incorporate small scale farms especially those with relatively weak biosecurity systems.

Under the PDSR system teams of mostly veterinary paraprofessionals undertook regular village surveillance using participatory techniques leading to heightened community awareness and to their then being called to villages to investigate apparent outbreaks of disease and conduct on site testing with rapid tests. Good information on village level prevalence of disease resulted in the areas covered, and nationally it can be expected that Indonesia has reasonable information of ongoing disease in small-holder poultry. A parallel benefit of the PDS was the training in field investigations and response for hundreds of animal health workers. However the scheme suffered from not being adequately funded to implement effective control measures, and the service became known as PDS. Another problem was its being unsustainable in its initial form because it was supported by donor funding and included remuneration packages for the workers involved being greater than for government employees. In some areas a transition from donor support to sustainable mechanisms has been trialled, but the ongoing sustainability of the approach is yet to be demonstrated.

ii. **Diagnosis and Quarantine**

Laboratory capacity building in support of diagnosis, and subsequently in the further characterization of viruses, has been a successful aspect of the Indonesian response. Biosafety considerations demanded an alternative diagnostic approach to virus isolation as the standard diagnostic approach. Real time PCR, supported by proficiency testing and trouble shooting support, has seen the technique successfully established in all national government laboratories and more broadly. However nationally there has not been full and effective use of this capability. Importantly, laboratory biosafety issues have been addressed to the extent possible with available facilities and laboratory acquired infections have not been reported. Molecular analyses of isolates even to the present time provide evidence that Indonesia suffered only one introduction of H5N1 infection (WHO/OIE/FAO, 2012) and that therefore national quarantine procedures and supporting biosafety communications have been effective.

iii. **Vaccination**

Where more direct measures to break the chain of transmission have not been implemented vaccination appears an attractive option, and has been used in Indonesia. Primarily it protects birds, and hence livelihoods, against disease and allows the commercial sector to function, fulfilling its role in national food security. Conceptually vaccination of poultry was also justified on One Health grounds, in that it can reduce the viral load in an otherwise contaminated environment and hence opportunities for exposure of the human population.

However mass vaccination at the village level was difficult to implement effectively and ultimately was unsustainable because of costs and the high turnover of poultry. Hence vaccination of village poultry was quickly dropped as government policy. The commercial sector, with controlled poultry populations in more biosecure facilities, continues to use vaccination, especially in long-lived poultry such as breeder birds and layers.

In Indonesia a wide range of vaccines containing different antigens was used but concerns quickly arose as to the suitability and effectiveness of available products. An internationally supported investigation under OFFLU (FAO 2010) confirmed problems of efficacy with some products, developed antigenic mappings as a tool for use with avian influenza and identified antigenic drift in viruses isolated from both commercial and village poultry. Indonesia now has the capability, with ongoing international collaborations, to identify vaccine antigens matched to currently circulating field strains of H5N1 (Wong et al, 2012).

The Indonesia agricultural sector, through participation in the international collaborations identified above, has continued to make H5N1 isolates available for international studies. This is of critical importance for these viruses are also analysed from a One Health (pandemic preparedness) perspective to identify whether antigenic drift is leading to strains against which the antigens in the antigen panel for the selection of human vaccines may not be effective. Development of some antiviral drug resistance has also been monitored and reported (McKimm-Breschkin et al 2012).

Public Health Issues

In spite of the massive response and investment in the animal health sector human H5N1 cases continue to occur. As of 12 April 2012 there have been 5 human cases this year, all fatal (WHO 2012b). The primary risk factor, infection in poultry, has not been successfully addressed. However the occurrence of new human infections also suggests that a continuing communications effort is needed to educate people at risk of exposure of that risk and the measures that they can take to manage that risk. The difficulties cannot be over estimated. The people at greatest risk are likely to be those for whom the fight against poverty is a daily battle, and for whom more hypothetical risks with a low probability of occurrence are not a primary consideration.

Summary

The experiences with H5N1 in Indonesia reinforce valuable lessons as outlined above (FAO 2011). Rapid diagnosis and response is critical in the management of disease emergencies. Where disease incursions or emergence are unchecked in situations where the animal and human populations are too numerous and also not educated, organized and resourced to mount effective responses infections will become entrenched. Actions that appear attractive because they can be implemented to a certain degree, such as surveillance or vaccination, will be inadequate to make significant impact. Ultimately infectious disease can be controlled only by absolutely breaking the chain of transmission, which will involve full disruption of existing practices along the value chain from producer to consumer for a sufficient period of time to allow infection to be eradicated in each production and marketing compartment.

6.2 LIVESTOCK VALUE CHAINS AND HPAI CONTROL IN THAILAND AND INDONESIA

Key messages

- Including value chain analysis is a vital and basic requirement in developing zoonotic disease control programs. Individual poultry smallholders do not work in isolation of their community, the contract companies, the input suppliers and even the consumers.
- This case study evaluated the private benefits required by smallholders to improve their biosecurity and how these benefits may be attained.
- HPAI also provides public benefit and therefore the costs of control need to be distributed between, all stakeholders and society in general.
- On farm biosecurity is influenced by all members of the value chain. Therefore, if HPAI is to be controlled, all stakeholders need to be involved and all stakeholders need to benefit.

Background

The first outbreak of HPAI (H5N1) was in South East Asia in late 2003. Since then several Asian countries have reported outbreaks and in some areas HPAI has become endemic. Outbreaks of HPAI have also been reported in Africa and Europe. In South East and Eastern Asia, over 300 people have died, and over 200 million poultry have died or been slaughtered, consequent to infection with HPAI virus. Since it was first identified in Indonesia in 2003, HPAI has become endemic in 31 of the 33 provinces. Along with Newcastle disease, Gumboro and other poultry diseases, HPAI is responsible for significant economic loss particularly in the Non-Industrial Commercial Poultry Sector (NICPS)¹⁷ and village poultry sectors. High mortality rates, decreases in demand for poultry and poultry products in affected areas, continuing human deaths and the risk of a global pandemic, ensure that control of HPAI remains a priority for Indonesia.

There have been differing national responses to HPAI outbreaks in South East Asia. These differences have been influenced by the size and nature of the poultry market and the influence that that has on public and community will. While understanding the epidemiology of HPAI and providing information and training for farmers is important, adoption will not necessarily be immediate. Adoption will be influenced by how farmers see or perceive the personal (not public) benefits. Encouraging adoption through the development of personal incentives (production or market) is required. It is also necessary to analyse the institutional (this includes, community, legislation, economic) environment within the farmers are living and working and, if required, identifying the appropriate point(s) of intervention in the value chain. A priority on training and informing farmers about disease movement and biosecurity may assume that the appropriate point of intervention is the farm, usually this is not the case.

HPAI control in Thailand and Indonesia

In order to understand better the importance of the social and economic environment in zoonotic disease control it is useful to consider the varying success of HPAI control in Thailand and Indonesia. There are significant differences in the responses, and the success of these responses, in the 2 countries mainly due to the differing incentive structures inherent in the respective poultry value chains. In Thailand the poultry sector is a sophisticated vital export industry (Thailand was the 4th largest poultry exporter before HPAI) while in Indonesia it supplies and large and growing domestic market (there is some export of processed chicken

¹⁷ The NICPS is defined as the non-industrial commercial poultry sector not owned and managed by the large, multinational, poultry companies that operate in Indonesia (and referred to as the industrial sector or Sector 1). This sector consists of layer and broiler farms ranging from 500 to 30,000 birds.

products). In Indonesia, 70% of annual production (1 million birds are consumed daily in Jakarta alone) is processed and sold through the traditional live bird markets. In Thailand, there was an imperative for the industry to work closely with the government to eradicate HPAI to preserve this valuable export market, this was not the case in Indonesia. This united approach to HPAI eradication in Thailand between the government and the poultry industry led to the rapid development of a National Strategic Plan and implementation of international guidelines for control. This included culling of birds, movement controls and the paying of effective compensation. X-ray surveillance was introduced in October 2004 and there was integrated effort of public health and animal health control authorities in bringing epidemic under control. In Thailand the public health community is organized, technologically sophisticated and well networked internationally and human health has long been held up as the central goal of HPAI prevention efforts. This was not the case in Indonesia. The unregulated nature of the market selling 80% of all birds in traditional markets made it impossible to control bird movements. The contract companies had little incentive to report disease as they knew the government response and availability of compensation would be limited. For the companies and the farmers it worked with, it was more efficient to simply sell sick birds (and their accompanying cohort) into the live bird market. While they may have received a lower price for a smaller bird, the loss was minimal and they knew there was no trace-back system for their birds. To assist in the control of HPAI in Indonesia there needs to be a market-driven program where contract companies and farmers have an economic incentive to work with government to control the disease. While the Government of Indonesia has attempted to provide the institutional support for HPAI control, the nature and size of the market has led to limited success. In terms of the nature of the industry the Thai response gave disproportionate advantage to large producers and nearly wiped out small commercial producers, the eradication program emphasised commercial interests over social impact a situation not possible in Indonesia due to the size of the smallholder systems and their importance in providing income and employment. In Indonesia 60% of the households (30 million) keep poultry, it is the most popular meat and consumption is rising every year. At present 1.2 billion chickens are consumed each year.

With this context it is clear that HPAI (and other poultry disease) control in Indonesia needs not only legislation and institutional strengthening, but also a concerted approach amongst all stakeholders in the value chain and development of public and private economic incentives for on-farm adoption of biosecurity measures.

Aims and objectives

The Australian Centre for International Agricultural Research (ACIAR) funded a project 'Cost-effective biosecurity for NICPS operations in Indonesia' from 2008-2012. This research project has prioritised the role of the market in HPAI control in Indonesia. It is based on the premise that, even though on-farm behaviour needs to change, this change will only occur if other appropriate interventions are implemented along the value chain. The Project has taken a value chain approach that is identifying appropriate, efficient and effective poultry biosecurity measures for NICPS farms. Interventions to encourage change at the production level need to be driven by changes at other parts of the value chain. This project has worked specifically at the industry (the companies involved in providing contracts to farmers) and the consumer levels, where demand for products from biosecure farms may be a driver for improved biosecurity adoption. The specific aim of the project is to **improve the economic viability of commercial broiler and layer producers through the sustainable adoption of cost-effective biosecurity measures**. The project is:

1. Developing an industry-driven and supported approach to improving on-farm biosecurity in the NICPS,

2. Defining the biosecurity measures that will improve the biosecurity and the economic viability of NICPS in Indonesia and,
3. Facilitating adoption of cost-effective farm and community biosecurity measures in NICPS.

Development context

HPAI is causing economic loss to all sectors of the Indonesian economy. There are production losses to farmers, which have flow-on effects to the contract companies and consumers. More importantly HPAI has directly been responsible for over 250 human deaths in Indonesia alone, and there is still a concern with regards to the likelihood of pandemic. It is important for Indonesia and the international community that HPAI is eradicated. If Indonesia wishes to develop a modern poultry sector providing efficient and safe products for the domestic consumer, it is important that poultry disease risk is minimised and the value chain sanitised. At present the structure of the market and the lack of united community, industry and government support ensures that HPAI cannot be effectively managed in the NICPS in Indonesia. Lack of biosecurity post farm gate, limited trace-back, multiple production cycles, low level of understanding of biosecurity, and minimal price differentiation between healthy and sick birds lead to poor implementation of farm biosecurity systems.

The Project is attempting to assist the government to do this, through the provision of training, development of a farm accreditation system and a 'clean market chain'. All stakeholders have been involved in biosecurity training activities. Resources have been devoted to training of farmers and advisors and facilitating the introduction of these biosecurity systems within communities. Farms have implemented agreed farm plans, have been independently audited and accredited. Service providers (those providing loans, credit, after-sales and membership services to poultry farmers) have been encouraged to introduce minimum biosecurity conditions in their contracts and pricing structures. Farmers who have implemented farm biosecurity plans receive production benefits (improved feed efficiency, lower drug costs, decreased mortality rates) and market benefits (premium price for their product in the supermarket). The project has attempted to identify market drivers for improved biosecurity on NICPS farms. This has involved the development of a 'clean market chain' in the 3 case study provinces whereby farms who adopt agreed biosecurity activities will have access to retail markets that provide a premium price. This has meant developing not only farms that implement farm biosecurity plans but also working with the RPA and the transporters to ensure procedures are in place that maintain hygiene and separation of biosecure farm birds from normal birds so that we can be sure the product sold at a premium are in fact from the Project farms. The Project has tested the development of a niche market as a driver for deriving private benefit through the adoption of improved biosecurity.

Role of key institutions, policies and stakeholders

The first step in identifying reasons for sub-optimal control of HPAI in Indonesia is through understanding the value chain i.e. how and where the stakeholders interact and how the product moves. Figure 1 illustrates the *people* involved in the movement of chicken and chicken products in Indonesia (specifically Bali and Lombok). This shows the number of people (although some individuals do play multiple roles) who need to be included in the disease control process. What is also important is the 'power' that the different players have in making decisions such as when to sell and when to buy DOC. Often this is not the farmer even though they are the owners of the asset.

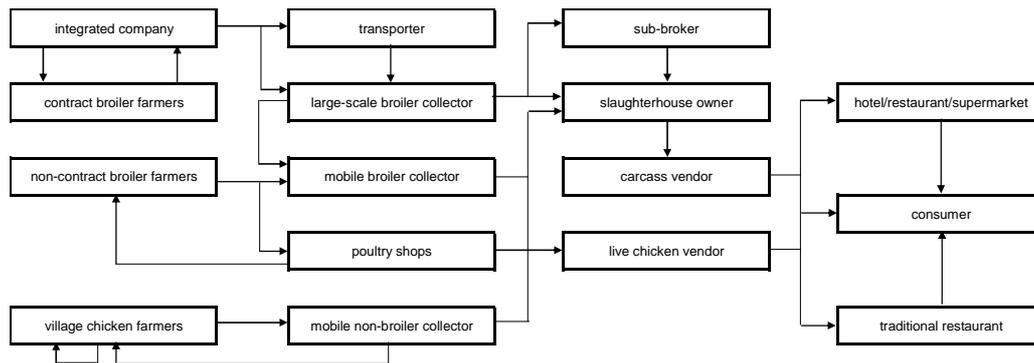


Figure 1: People in the poultry value chain

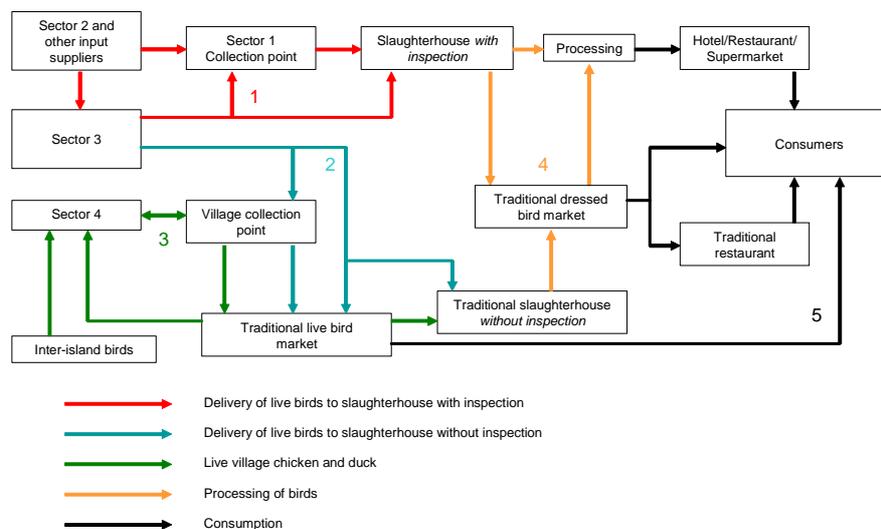


Figure 2: Places in the poultry value chain

Figure 2 provides a different perspective, it illustrates the *places* where chickens move and potentially interact with other species and poultry from other areas. If the actual number of places where the change of ownership of the chicken/product occurs can be reduced, potentially disease movement can also be reduced. This, however, can have significant social and employment consequences.

Many private and public companies and institutions have significant influence on NICPS smallholders (including multinational contract companies, banks, poultry shops, drug companies, feed companies, poultry associations and government). The key for the Project has been the active partnership of industry in developing appropriate biosecurity activities and encouraging adoption. At the national level the Project has formally partnered with the *Forum Masyarakat Perunggasan Indonesia* (FMPI – Indonesian Poultry Forum) - an umbrella organisation which facilitates cooperation and partnership between all sectors of the poultry industry and government. At the provincial level (the Project works in 3 provinces in Indonesia; Bali, West Java and South Sulawesi) the Project has established Provincial Steering Committees (PSC). These committees mirror the FMPI with representatives from all stakeholder groups, not only advising the Project on appropriate activities, but also taking an active role in implementing activities. Each PSC is headed by a member of the local farmer association which has provided the project access not only to the farmers but also to the contact companies and *rumah potong ayam* (RPA – poultry slaughterhouses). Through links with the RPA the project has also worked with targeted supermarkets.

Ultimately the consumers have the potential to influence management systems. There is an increasing push within the Indonesian middle class for the production of clean, green food. The Project has included consumers in the market trial, first of all through a consumer survey to see what they would be prepared to pay for products from biosecure farms and then actual selling of a 'Healthy Farm' product which is attracting premium prices. It is hoped that in the future all poultry products are being produced in accredited, clean farms.

Key successes, challenges and lessons learned

Lack of biosecurity adoption in the NICPS is due to firstly, poor understanding of disease movement and the role that farmers can play in minimising disease, and secondly, the lack of market incentive to invest in biosecurity. The Project has impacted on both issues through training of key stakeholders in the market chain (farmers, slaughterhouse operators, farm advisors and other support sector staff that transact with farmers e.g. bankers, government policy makers) and through the development of a 'clean market chain' where farmers who implement agreed farm biosecurity plans gain access to higher price supermarkets.

The key successes have been:

- Improved understanding of disease movement and the role of biosecurity in reducing disease risk
- Facilitating working relationships between farmers, RPA and supermarkets
- Consumers in supermarkets are paying more for chicken meat and eggs produced on biosecure farms (up to 30% higher)
- Farm accreditation systems are possible
- All stakeholders in the value chain have been trained in biosecurity and hygiene

The key challenges are:

- Trust between stakeholders
- Ensuring farmers accrue benefits from the premium prices
- Developing a government or industry farm accreditation system
- Encouraging industry and government to work together
- Contracts encourage farms to invest in biosecurity
- Minimising transaction costs and activities while meeting social and community employment expectations
- Having government involved in paying for the public benefits, the full burden of disease control should not fall on individuals and companies
- Ensuring demand for certain poultry products for community/religious purposes are acknowledged and included in the research
- NICPA smallholders do not have sufficient control over purchasing and selling decisions and even decisions that include who can enter their farm and when

Including value chain analysis is a vital and basic requirement in developing zoonotic disease control programs. Individual poultry smallholders do not work in isolation of their community, the contract companies, the input suppliers and even the consumers. The project discussed above has provided a first case study or trial to evaluate the private benefits required by smallholders to improve their biosecurity and how these benefits may be attained. It must be remembered, however, that HPAI also provides public benefit and therefore the costs of control need to be distributed between, all stakeholders and society in general. On farm biosecurity is mainly influenced by other members of the value chain, therefore, if HPAI is to be controlled, then all stakeholders need to be involved and all stakeholders need to benefit if changes in behaviour are required.

6.3 RIFT VALLEY FEVER

Key messages

- RVF occurs as a periodic epidemic affecting particularly small holder livestock keepers and affects both animals and humans. These epidemics occur in large part due to climatic changes affecting vector distribution and numbers.
- These epidemics can be predicted to an extent through appropriate climate based modeling.
- Vaccines used prior to an epidemic will be effective in controlling outbreaks and the associated losses.
- Research should focus on improving climate models, vaccines and societal factors around vaccine uptake.
- Such research will need to be multidisciplinary (using a “one health” approach) given the intrinsic links between human and animal health, climatic factors, productivity and societal issues.

Background

Rift Valley fever (RVF) is a viral zoonosis that primarily affects animals but also has the capacity to infect humans. Infection can cause severe disease in both animals and humans. The disease also results in significant economic losses due to death and abortion among RVF-infected livestock.

RVF virus is a member of the Phlebovirus genus, one of the five genera in the family Bunyaviridae. The virus was first identified in 1931 during an investigation into an epidemic among sheep on a farm in the Rift Valley of Kenya. Since then, outbreaks have been reported in sub-Saharan and North Africa. In 1997-98, a major outbreak occurred in Kenya, Somalia and Tanzania and in September 2000, RVF cases were confirmed in Saudi Arabia and Yemen, marking the first reported occurrence of the disease outside the African continent and raising concerns that it could extend to other parts of Asia and Europe. Since then, concerns has continued to grow of the risks RVF poses to many developed and developing countries.

RVF is able to infect many species of animals causing severe disease in domesticated animals including cattle, sheep, camels and goats. Sheep appear to be more susceptible than cattle or camels. Age has also been shown to be a significant factor in the animal's susceptibility to the severe form of the disease: over 90% of lambs infected with RVF die, whereas mortality among adult sheep can be as low as 10%. The rate of abortion among pregnant infected ewes is almost 100%. An outbreak of RVF in animals frequently manifests itself as a wave of unexplained abortions among livestock and may signal the start of an epidemic.

While most human cases are relatively mild, a small percentage of patients develop a much more severe form of the disease. This usually appears as one or more of three distinct syndromes: ocular (eye) disease (0.5-2% of patients), meningoencephalitis (less than 1%) or haemorrhagic fever (less than 1%).

Several different species of mosquito are able to act as vectors for transmission of the RVF virus. The dominant vector species varies between different regions and different species can play different roles in sustaining the transmission of the virus. Among animals, the RVF virus is spread primarily by the bite of infected mosquitoes, mainly the *Aedes* species, which can acquire the virus from feeding on infected animals. The female mosquito is also capable of transmitting the virus directly to her offspring accounting for the continued presence of the RVF virus in enzootic foci. During periods of heavy rainfall, larval habitats frequently become flooded enabling the eggs to hatch and the mosquito population to rapidly increase, spreading the virus to the animals on which they feed. There is also a potential for epizootics and associated human epidemics to spread to areas that were

previously unaffected. This has occurred when infected animals have introduced the virus into areas where vectors were present and is a particular concern.

Outbreaks of RVF in animals can be prevented by a sustained programme of animal vaccination. Modified live attenuated virus, inactivated virus vaccines, subunit vaccines and DNA vaccines have been developed for veterinary use. Only one dose of the live vaccine is required to provide long-term immunity but the vaccine that is currently in use may result in spontaneous abortion if given to pregnant animals. The inactivated virus vaccine does not have this side effect, but multiple doses are required in order to provide protection which may prove problematic in endemic areas. Significantly, animal immunization must be implemented prior to an outbreak if an epizootic is to be prevented. Once an outbreak has occurred animal vaccination should NOT be implemented because there is a high risk of intensifying the outbreak.

Forecasting can predict climatic conditions that are frequently associated with an increased risk of outbreaks, and improve disease control. In Africa, Saudi Arabia and Yemen RVF outbreaks are closely associated with periods of above-average rainfall. The response of vegetation to increased levels of rainfall can be easily measured and monitored by Remote Sensing Satellite Imagery. In addition RVF outbreaks in East Africa are closely associated with the heavy rainfall that occurs during the warm phase of the El Niño/Southern Oscillation (ENSO) phenomenon. These findings have enabled the successful development of forecasting models and early warning systems for RVF using satellite images and weather/climate forecasting data. Early warning systems, such as these, could be used to detect animal cases at an early stage of an outbreak enabling authorities to implement measures to avert impending epidemics. Within the framework of the new International Health Regulations (2005), the forecasting and early detection of RVF outbreaks, together with a comprehensive assessment of the risk of diffusion to new areas, are essential to enable effective and timely control measures to be implemented.

Finally and importantly, RVF is considered suitable as a biological weapon since several genera of mosquitoes found in the United States can serve as vectors for RVF virus (eg, *Aedes*, *Anopheles*, *Culex*) and the disease could become endemic following an intentional release. This pattern recently has been illustrated following the natural introduction of West Nile virus (which also is a mosquito-borne disease) into North America. RVF virus infects both humans and livestock and could, therefore, cause both economic damage to the livestock industry and human morbidity and mortality and once introduced into a new area, the disease would be difficult to eradicate.

Aims and Objectives

From a global perspective, RVF represents one of the highest emerging disease risks, both as a zoonotic agent but also as a potential bioterrorist weapon. Notwithstanding this, the use of predictive bio-modeling and new generation vaccines offer a genuine opportunity to significantly mitigate these risk, particularly in terms of a naturally occurring event. For this to occur, more effect climatic models need to be developed that take into account not only the climatic conditions but how these affect vector numbers and vector movement and how this links to livestock regions of importance. This in turn will lead to more robust predicative models and the ability to take effective action, particularly in terms and livestock vaccination. A second aim, will be to develop cost effective vaccines that can be applied in the developing country context, that is, are themostabile, affordable and efficacious with a single dose. Finally and importantly, demonstration models of the effectiveness of these interventions need to be undertaken to encourage and drive uptake of the vaccine at these crucial periods as post event vaccination is ineffective. Much of this work has been undertaken, with a considerable amount of work targeted at new generation vaccines. A number of climatic modeling tools are now available but require application over time to demonstrate utility. Cost benefit studies based on preventative vaccine are lacking, particularly in the developing country settings.

Developmental Context

RVF poses a significant threat to small holder and subsistence farmers in endemic areas and those deemed at risk. Not only are there significant losses directly to livestock and livestock productivity but the human health costs are equally high during the epidemic phase. An analysis in Kenya of the public health burden of RVF outbreaks measured in disability adjusted live years (DALYs) – the first of its kind in Kenya – shows that the 2006 and 2007 outbreak resulted in 3.4 DALYs per 1000 people and household costs of about Ksh 10,000 (USD120) for every human case reported. In 2008, ILRI estimated the disease cost the Kenyan economy USD30 million. These levels of losses will be mimicked in other African and Middle East countries where RVF has occurred.

Role of Key Institutions, Policies and Stakeholders

A new effort to align the work of partners in eastern Africa and implement more synergetic research on RVF was the focus of a recent multi-stakeholder workshop that reviewed research strategies and approaches used by veterinarians, epidemiologists, economists and public health experts in projects across Kenya.

The meeting, which was held at the International Livestock Research Institute (ILRI) in February 2012, discussed ILRI's RVF research program, potential collaborations with partners and options of controlling RVF.

Participating organizations, which are conducting research on RVF, included Kenya's ministries in charge of livestock development and public health, the universities of Nairobi and Egerton, Kenya Agricultural Research Institute and Kenya Medical Research Institute. Also attending the workshop were staff of the African Union Interafrican Bureau for Animal Resources (AU-IBAR), Swiss Tropical and Public Health Institute, the Nairobi office of the US Centres for Disease Control and Food and Agriculture Organization of the United Nations (FAO). This "One Health approach is supporting joint assessments of the prevalence of zoonotic diseases in both animals and humans and are helping to increase the relevance of the research leading to more effective interventions. And the underpinning policies.

This strategy should lead to lower costs of doing research and implementing human and animal health interventions and a reduced burden of Rift Valley fever on the region's livestock, people, wildlife and markets.

More broadly speaking, the risk posed by RVF are no longer considered as restricted to the endemic areas of Africa and the Middle East, but include an area where competent vectors exists. Linked in the bioterrorist risk and key stakeholders become global in nature. Whilst this serves to increase the resources available for research on RVF, it also sees much tighter restrictions on who and where research can be undertaken.

Key Successes, Challenges and Lessons Learned

RVF is an epidemic of livestock that causes significant losses to smallholder farmers in developing countries that potentially is predictable and avoidable. Three major issues need to be addressed to create this desirable situation. Firstly we need to develop effective climate based prediction models that enable effective and timely vaccination. Secondly, the development of vaccines that are affordable, appropriate for use in the developing country situation (one inoculation for effective immunity) and do not produce any side effects such as abortions, and thirdly an education and communication program that will ensure the uptake of vaccination at the appropriate time e.g. before outbreaks start occurring. All of these goals are achievable with appropriate resources and an element of innovation.

The meeting in Kenya discussed gaps in current research practice including the absence of climate models, sampling tools and methods to support decision support tools. Participants highlighted the need for a vector profile of the disease to enable mapping of most affected and high-risk areas and the need to understand how Rift Valley fever interacts between livestock and wildlife. During the meeting, ILRI shared findings from a collaborative project known as 'Enhancing prevention and control of Rift Valley fever in East Africa by inter-

sectorial assessment of control options.’ For example, findings from the project also included a dynamic herd model developed for pastoral systems for simulating herd dynamics during normal and drought periods and in Rift Valley fever outbreaks. This model will be used to simulate the impacts of prevention and control options for the disease.

Esther Schelling, a epidemiologist with the Swiss Tropical and Public Health Institute, and formerly a researcher with ILRI, said: ‘Collaborative efforts in addressing the challenge of Rift Valley fever can support “one health” initiatives that seek to raise the research profile of neglected zoonotic diseases in Africa and improve the effectiveness of interventions through joint surveillance, preparedness and contingency planning to reduce the amount of time it takes to control outbreaks of these diseases.’

The prevention and control options discussed at the meeting will be further simulated using the herd dynamic model, which will be followed by an economic analysis using a process that was agreed on in an earlier (September 2011) workshop that discussed Rift Valley fever surveillance. A cost-benefit analysis of vaccination, vector control, surveillance, and sanitary measures is now scheduled. Results from the analysis will give much-needed evidence to support creation of policies and strategies for appropriate surveillance, prevention and control of Rift Valley fever in eastern Africa.

According to Tabitha Kimani, an agricultural economist with ILRI, ‘preliminary cost benefit analysis is already showing that it is beneficial to control Rift Valley fever through vaccination.’

Development of safer and more effective RVF vaccine is though required to protect humans and ruminants from RVF during outbreaks. Considering the possibility that RVF may circulate long-term in mosquito populations, an effective vaccination should elicit long-term protective immunity, both in human and animals to prevent further spread of RVF. Several new generation vaccines are currently under development, and their further improvement will facilitate our preparedness for potential introduction of RVF into the U.S. and other non-endemic countries. TSI-GSD 200 is a safe vaccine candidate for human; however, primary and follow-up booster administrations are required for maximum protection against RVF. MP-12, which is highly immunogenic, is under development as both a human and veterinary vaccine.

6.4 BOVINE BRUCELLOSIS IN TIMOR ISLAND

Key messages

- Effective control and eventual elimination of brucellosis from the island of Timor will require close cooperation between the governments of Indonesia and Timor Leste as well as sustained donor funding and technical assistance, possibly from Australia.
- Careful crafting of policies, with attention to national development priorities and socio-economic and cultural considerations of local communities in both countries, will be essential for long term success.
- Engagement with stakeholders to understand the beef value chains in both countries could allow creation of mechanisms for orderly marketing of cattle to prevent further brucellosis spread and accelerate control, while delivering value to smallholders.
- Capacity building needs at all levels in both countries needs careful attention.

Background

Bovine brucellosis (contagious abortion) causes major disruptions to cattle production systems through reproductive losses as well as severe chronic illness in people, especially those occupationally exposed (farmers, abattoir workers, veterinarians, laboratory workers) or consuming raw milk products. It has been eradicated or is highly controlled in many developed countries, but still remains a large problem in the developing world. The experiences of brucellosis control in Australia and on the island of Timor provide valuable lessons about the types of policies, institutions and stakeholders which need consideration in different contexts.

Australia's successful bovine brucellosis eradication campaign from 1970 -1989 (Lehane 1996) relied on:-

- **Sound technical and regulatory policies** – Vaccinating female calves in high prevalence cattle populations for some years, then banning routine vaccination to reduce interference with serological diagnosis; testing all female cattle and slaughter of reactors (with compensation) once area prevalence had declined; herd and area (zone) status updates with appropriate movement controls and cattle identification to herd of origin; and comprehensive surveillance of adult cows by abattoir monitoring, monthly milk ring testing of dairy cows and at least two rounds of field whole herd testing;
- **High level institutional commitment** - Cost sharing and decision making between cattle industry and all Australian governments, via a national Brucellosis and Tuberculosis Eradication Committee (BTECC); strong legal powers and implementation by State / Territory governments, and Commonwealth government coordination, information management and industry levy collection and disbursement; and
- **Strong stakeholder engagement** – This included beef and dairy cattle farmers and their organizations at state and national levels, cattle traders and transporters, abattoir and dairy factory operators, and private and government veterinarians.

Timor Island (Indonesia and Timor Leste) was probably infected with brucellosis in the early 1970's by breeding cattle brought from Australia to a ranch in north-west Timor breeding cross-bred cattle for later smallholder distribution. By the early 1990's, sero-prevalences as high as 90% were recorded in some nearby villages, though parts of south-west Timor remained uninfected. The Indonesian government, with technical and funding assistance from the Australian-funded Eastern Islands Veterinary Services project (EIVSP), implemented a brucellosis control program modeled on Australia's program, with Strain 19 vaccination of female cattle in north-west Timor and movement controls and test-and-slaughter in south-west Timor (AusAID 1995). Later surveillance in East Timor indicated that brucellosis had also spread widely there, though little control was undertaken before independence.

EIVSP focused particularly on strengthening field veterinary and para-veterinary services, with necessary laboratory support as a secondary objective, through the extending network of animal health posts which were being built and staffed by the Indonesian government. Extensive staff training and provision of basic equipment, transport (motor bikes) and cold chain facilities allowed systematic implementation of key vaccination programs and other control against severe livestock diseases, as well as improving surveillance and general response capability. Ability of smallholders to benefit from livestock husbandry was greatly enhanced by initiatives targeted at village poultry production (especially empowering women) and by support for cattle grower groups (male). The capacity building effects of EIVSP were particularly strong and many of the people trained are now in senior positions in the Livestock Services of both Indonesia and Timor Leste. This has contributed greatly to continuation of, and maintenance of government commitment for, the brucellosis control program in West Timor

Current situation in Timor

Achieving self-sufficiency in beef production is a key objective of the Indonesian government. The savannah grasslands of eastern Indonesia, including Timor, provide an ideal environment for breeding beef cattle for distribution as meat or breeding stock to other parts of Indonesia and Timor Leste, improving food security and reducing rural poverty in both countries.

Endemic bovine brucellosis on the island of Timor constrains this potential and remains a public health hazard. Brucellosis profoundly impacts smallholder livelihoods, severely reducing reproductive efficiency of affected cows. This also flows through to the overall capacity of Timor to produce cattle and increase self sufficiency in beef. Notably, exports of breeding cattle from Timor to other parts of Indonesia, and from Timor Leste to Indonesia, are now banned due to the presence of brucellosis. This lowers overall prices received for cattle from Timor, and especially from Timor Leste, as values for breeders are higher than for meat cattle. The demand for breeding cattle also increases the risks of illegal movements of cattle from Timor to Flores or Sumba islands, which would spread brucellosis to those islands, currently hoped to be brucellosis free.

The previous attempts to control brucellosis effectively on the whole island of Timor from the early 1990s, described above, have been severely compromised by the disruption of veterinary services in East Timor since independence, and the variable budgets and complex issues posed by decentralisation and regional autonomy in West (Indonesian) Timor. However, useful preliminary research on brucellosis in West Timor (ACIAR 2012) demonstrated that control by vaccination in more heavily affected areas of Indonesian West Timor (Belu district) is having some effect, but that there is an increasing prevalence in Kupang district where no vaccination is practised, and that increased brucellosis control would be highly cost effective.

ACIAR funded Scoping study

A scoping study on brucellosis in both East and West Timor is being carried out by the University of Sydney in 2012. It aims to assess prospects for improving market supply of beef cattle through improved brucellosis control and identify knowledge gaps and threats and opportunities. Visits have been made to the central governments of both Indonesia and Timor Leste, and the governments of Nusa Tenggara Timur (NTT) province, the five districts of West Timor and some of Timor Leste's thirteen districts.

All government officials spoken to at all levels in both countries expressed a strong commitment to improving brucellosis control and thereby reducing rural poverty. In Indonesia, this is driven by the beef supply chain imperatives set out above, and commitment is proven by recent significant budget increases from central and district governments to strengthen existing NTT brucellosis control programs. Indonesia requests a road map for brucellosis eradication from the whole of Timor island and NTT, identifying not only research needs to

support such a program but also beef market supply efficiency improvements, human capacity building and infrastructure needs.

Timor Leste wants to regain market access for smallholders to be able to sell cattle to West Timor, and realizes that brucellosis control will be a key step in this. There has been no brucellosis control or surveillance in Timor Leste since independence and it is likely that prevalence is high with corresponding production and health impacts. This is against a background dearth of information about and effective control of both animal and human health problems. Poverty associated constraints in Timor Leste include very poor roads and infrastructure, lack of human capacity at all levels, poor literacy levels and lack of a single common language. However, an excellent census in 2010 has given very accurate information about important socio-economic parameters which will assist planning.

Movements of livestock across the porous international borders in Timor pose major disease risks and, due to local cultural and family ties, as well as market price differentials and local geography, are extremely difficult to prevent. This poses grave risks of regular re-introduction of brucellosis from East to West Timor which renders eradication effectively impossible at present. A sustainable solution to the brucellosis problem will need an integrated whole-of-Timor program which implements a long term, well funded, evidence-based strategy.

Further consultation between Australian, Indonesian and Timor Leste representatives will hopefully achieve agreement on a long term road map / framework for progressive brucellosis eradication from Timor. Major issues that need to be addressed include integrated government policy and implementation at central, provincial and district levels between the two countries, as well as improvements in cattle identification and beef value chain management, diagnostics, and professional and community knowledge and capacity.

6.5 HYDATIDOSIS IN ICELAND, SICHUAN PROVINCE, CHINA, AND TURKANA, KENYA

Key messages

Best results from hydatidosis control programs have occurred when a well managed control authority implemented a medium to long term self-funded campaign directed at a community that had been properly engaged during the planning phase.

Effective participatory planning between animal owners and community leaders is needed to evaluate possible control technologies and to enable a choice of those aspects that suit the sociology and economic status of the particular community.

Sociological surveys may be required during the planning phase to elucidate relevant information about the social structure and the life style patterns of the target population.

Maintaining community interest in and ownership of the program is vital for long-term success.

Introduction

Hydatidosis is a serious zoonotic parasitic infection in humans that is transmitted between dogs, the usual definitive host and an intermediate host, usually sheep, with humans occasionally becoming infected as an unusual intermediate host. Hydatidosis occurs when a person accidentally ingests the tiny parasite eggs that are passed out in the faeces of infected dogs, which can then develop though to the intermediate form of the parasite - a large, potentially life-threatening cyst in the liver, lung or brain of the affected person.

High prevalence of hydatidosis is often seen in relatively poor rural pastoral societies that have little access to health facilities - factors that inevitably complicate any effort to control or prevent infection.

Control programs against hydatidosis have been implemented in many countries, with varying degrees of success. Most notably, as a result of purposeful campaigns, hydatidosis has been eliminated from two countries, Iceland and New Zealand, and from the island state of Tasmania, Australia (Craig & Larrieu 2006).

Hydatid control programs have been divided into three phases - Planning, Attack and Consolidation (Gemmell et al. 2001). This approach is applicable to control programs aimed at other endemic zoonotic disease.

The planning phase may involve sociological surveys; establishment of baseline information about prevalence of infection in humans and animals; determining the sources of human infection and establishing clear and efficient mechanisms to break the transmission cycle. Planning should engage all stakeholders including animal owners, appropriate government bodies and human and animal health experts. Systems for financial support should be agreed by all participants.

The attack phase involves a range of procedures agreed during the planning phase. This may include education of the target population; control and treatment of animal populations; changing animal husbandry practices to reduce transmission and surveillance of human and animal infection.

Finally, the consolidation phase begins when an acceptable level of control has been achieved. The most cost-effective control measures to maintain this level of control are then used. Surveillance must still take place (Heath et al. 2006).

The best results from hydatidosis control programs have occurred when a well managed control authority implemented a medium to long term self-funded campaign directed at a community that had been properly engaged during the planning phase, and with appropriate community educational programs and surveillance systems in place during the attack phase (Craig & Larrieu 2006). Three short case-studies of hydatidosis control programs, conducted in Iceland, China and Kenya are provided below, in order to highlight the vital importance of polices, institutions and stakeholders in delivering successful outcomes of endemic zoonotic disease control programs.

Iceland eradicates Hydatidosis - a remarkable success story based on community engagement and strong institutional support.

Historically, Iceland had a very high prevalence of hydatidosis. Autopsies conducted at the beginning of the 20th Century on people born in the 1840's indicate a prevalence of about 30%.

The Icelandic Hydatid campaign began in 1864, very soon after the life cycle of the parasite was elucidated. An excellent overview of the campaign is provided by Craig and Larrieu (2006), some of which is summarised here.

The initial aim of the program was to develop an understanding of the disease amongst the Icelandic population and a sense of responsibility for its control. Two pamphlets, which explained the life cycle of the disease and methods of control, were distributed free of charge to every household in Iceland, with massive positive impact, probably aided by an unusual set of local circumstances. At that time, apart from the Bible and Icelandic sagas, there were very few books written in Icelandic language. Consequently, the hydatid pamphlets became one of the most widely read works by the poor but highly literate Icelandic society.

The community were thus engaged, and pushed for government action. The Icelandic government subsequently agreed to a nation-wide control program and passed laws that provided the bed-rock of the future success of the program. The Hydatid Act imposed a tax on every dog, thus helping to fund the program. It also outlawed feeding of dogs offal from slaughtered sheep, thereby making the main form of disease transmission illegal. Significantly, the law also required that every dog should be treated ('cleaned') once a year and stipulated that each community was required to nominate a 'dog cleaner', and purpose-built 'dog cleaning house'. This act was refined and upgraded to meet the program's changing requirements in 1924, 1953 and 1957.

A number of value-chain changes also improved hydatid control. Slaughterhouses were built and it became illegal to kill livestock on farms. Sheep were slaughtered at younger ages, thereby reducing the likelihood of infection.

The instigators of the campaign were prescient in suggesting that generations of effort would be required before full benefits of the campaign would be observed. Both the government and community were thus prepared for a long haul. Maintaining community enthusiasm in the program was no doubt made easier not

only because the Icelandic population was small, relatively homogenous and clearly defined but also because the community received surveillance data indicating their combined efforts were reaping the desired rewards.

By 1900, new cases of human hydatidosis had virtually disappeared. Eradication was now considered feasible, but would rely on the country remaining totally closed to the introduction of new definitive or intermediate hosts, a clear possibility given Iceland's isolated island geography. Appropriate governmental controls were put in place and the program continued with eradication as the target. By 1949, the prevalence within sheep was about 0.0008%. The last recorded human diagnosis of hydatidosis occurred in 1960, in a lady who probably was infected decades earlier. Iceland had successfully eradicated hydatidosis.

Hydatid control amongst Tibetan herdsman in Sichuan Province, China – ensuring the programs suits the sociology and economic status of the community

Hydatidosis remains a persistent problem in western China, including western Sichuan, where it is estimated that 12% of the population are infected. A pilot program to control hydatidosis amongst Tibetan herdsmen in Sichuan province met with limited success, due to a number of sociological, institutional and policy factors. Full details of the program have been described by Heath et al. (2006), a summary of which is provided here.

An initial survey conducted to elucidate the social structure and the life style patterns of the people highlighted that the implementation and impact of hydatid control mechanisms would be limited by the poor educational status of the population. It also concluded that the beneficiaries of the project, particularly the women and children, needed to be involved in all assessments and evaluations during the attack phase. It was decided that communication and education would be channelled through community leaders.

But who were the local leaders? Local leaders promoted by the Chinese did not hold the same respect and power as the Lamas, the traditional leaders of the Tibetan people. But Chinese governmental policy stipulated that local Tibetan appointees were expected to be the arm of Government. A lack of effective communication channels restricted the educational arm of the project and after six years, only 40% of the target population understood the hydatid life cycle.

Little or no progress was made on another important aim of the program: to remove, by euthanasia, the estimated 1,500 unwanted dog in the region. The Buddhist religion, which forbids the shedding of blood from a living thing, proved a stronger force than any arguments about the danger that unwanted dogs may cause to the local population. Similarly, an attempt to regularly treat all wanted dogs in the region met with only partial success. Follow-up surveys indicated that many dog owners did not trust the pills that were distributed free of charge and were throwing them away.

The program also suffered from inadequate financial arrangements. After the first year, when people had not been paid for their work, the project faltered until money was finally allocated several years later. In retrospect, it was concluded that hydatid control should be mainly self-funded, which requires the support of the animal owners.

The existing value chain in the region made monitoring of the prevalence of infection in livestock very difficult. Very few sheep and goats were sold, and none for slaughter at the only local abattoir. Consequently, data on prevalence of infection in these species was limited to a few animals purchased specifically for necropsy.

The limited veterinary services in the region also hampered the project. The proposed vaccination program for the livestock grazing in the region was beyond the realistic capacity of the local veterinary staff to deliver and turn-over of staff also caused difficulties.

A main conclusion of the pilot program was that effective participatory planning between animal owners and community leaders is needed to evaluate possible control technologies and to enable a choice of those aspects that suit the sociology and economic status of the particular community.

Northwest Turkana, Kenya – resourcing and understanding difficult and complex environments

One of the highest annual surgical incidences of hydatidosis ever reported (about 200 cases/100,000 people/year) was observed in the north of the Kenyan district of Turkana about 25 years ago, triggering the development of a control program for hydatidosis in the region. Craig and Larrieu (2006) review that campaign, some of which is summarised below.

The control zone was in a remote part of Kenya, with a population of about 12,000 Turkana tribespeople, most of whom lived a nomadic or semi-nomadic lifestyle. From the outset, it was realised that the control of hydatidosis would be difficult for the following reasons: the Turkana tribe were a mostly illiterate, marginalised population; inter-tribal livestock raiding and fighting was common; there were virtually no educational, medical or veterinary facilities; there were poor communications and road networks and there were no abattoirs in the region.

Moreover, the complex social, ecological and economic factors contributing to extremely high prevalence rate of hydatidosis in the region were not well understood when the attack phase of the program started, with consequent negative impacts on outcomes. Subsequent studies showed that anthropological factors, such as the use of dogs to clean and nurse babies, the use of dog faeces as a lubricant and a medicine, and other very close human-dog relationships, were important factors requiring specific interventions. Further, in addition to the expected dog-sheep disease cycle, there was the possibility of other disease transmission cycles requiring specific interventions, including a dog-human disease cycle occurring because Turkana often do not bury their dead, making it possible for dogs to eat the cadavers; a dog-camel disease cycle and, finally, a separate wild canid disease cycle.

Complex and difficult circumstances are good arguments for extra resources rather than fewer. Unfortunately, there was one physician, one veterinarian, six technical assistants, one educationalist and about 10 local health workers who had responsibility for the entire design, delivery and monitoring of the program.

While the program had some impact on transmission and reduction in human morbidity, it could never enter a 'consolidation' phase, because the 'attack' phase was not sufficiently comprehensive. From the late 1990's the limited resources of the programs were re-focused towards health education and patient management. The concept of combining control of more than one zoonotic disease and integrating medical and veterinary outreach programs was suggested as an option for hydatid control in this difficult and challenging environment.

6.6 NIPAH VIRUS EMERGENCE IN MALAYSIA, BANGLADESH AND INDIA

Key messages

- Emerging diseases often occur first in a way that is difficult to discern from the normal background noise, and surveillance needs to be sensitive and across the animal-human spectrum. They may not become obvious until some form of ecological change, such as the movement of diseased animals to areas of intensive farming, as in this case.
- Good communication between veterinary and medical personnel is essential to ensure that zoonotic disease is detected early so that a response to control and/or mitigate can be implemented before the outbreak becomes too extensive or large.
- The size of the farm, whether small-holding or larger, intensive operations, can be equally susceptible to disease outbreaks if surveillance is inadequate, or adverse ecological conditions are not recognised.
- Novel diseases may not always present in predictable ways, and the presentation may vary between regions and individuals and may vary also in modes of transmission.
- Novel zoonotic diseases may occur more widely than outbreak incidence would indicate, and may not be restricted by reservoir host species or by geographic range or ecosystem.

Nipah virus in Malaysia

A major outbreak of a novel disease in pigs and humans occurred in Peninsular Malaysia between September 1998 and April 1999 resulting in 265 human cases of which 105 were fatal, and the eventual culling of about 1.1 million pigs to bring it under control (Chua et al. 2000). The disease first appeared in Perak, an area with many small family-owned pig farms and smallholdings, as sporadic cases of encephalitis thought to be Japanese encephalitis. The new disease wasn't identified in pigs initially as morbidity and mortality rates were not excessive, and the clinical signs were not markedly different from those of other diseases of pigs in peninsular Malaysia. The outbreak then spread to a major, intensive pig-producing area in the State of Negeri Sembilan, just south of Kuala Lumpur, where it reached a peak in March 1999. Almost all clinical cases were associated with people in close contact with pigs, either through farming, or through transport or slaughter of pigs. The predominant clinical syndrome in humans was encephalitic, with clinical signs including fever, headache, myalgia, drowsiness, and disorientation sometimes proceeding to coma within 48 h (Chua et al 1999). Human-to-human transmission was not observed. The disease in pigs was highly contagious, and characterized by acute fever with respiratory involvement with or without neurological signs in all age classes (Nor et al, 2000). Incubation was estimated to be 7–14 days. Crude case mortality was low (<5%), and notably, a large proportion of infected pigs was asymptomatic. Evidence of Nipah virus infection was also been found in dogs, cats and horses (Chua et al. 1999; Nor et al. 2000). A previously unrecognised paramyxovirus, related to Hendra virus, was isolated in cell culture, and subsequently named Nipah virus after the name Evidence of Nipah virus infection was of the village from where the virus was first recovered (Chua et al. 1999). Retrospective investigations suggest the virus had been responsible for disease in pigs in Peninsular Malaysia since late 1996. Epidemiological evidence suggested that during the outbreak, the primary means of spread between farms and between regions was the movement of pigs, whereas the primary mode of transmission on pig farms was believed to be via the respiratory route. Pig-to-pig transmission was common, but there was no good evidence of human-to-human transmission. The outbreak spread to an abattoir in Singapore through infected animals where there was a cluster of 11 cases in abattoir workers with one death.

During the early phases of the outbreak in Perak, the human cases of encephalitis were believed to be caused by Japanese encephalitis virus, a virus endemic in much of Malaysia, but mosquito-control measures and vaccination were ineffective at controlling the disease. However a lack of communication between medical and veterinary officials resulted in the failure to recognise that Japanese encephalitis virus does not kill pigs, and

thus may not have been responsible most of the human infections. In 17 March 1999, the Cabinet Task Force Committee was set up during the Parliamentary Cabinet meeting. The Cabinet Task Force Committee was chaired by the Deputy Prime Minister with direct involvement of Ministers of 7 Ministries (Health, Transport, Primary Industry, Public Works, Housing and Local Government, Agriculture, and Finance) and Deputy Ministers of 3 Ministries (Information, Defense, and Home Affairs). The Secretariat for the Cabinet Task Force Committee was chaired by the Director-General of Health. State Outbreak Committees and District Outbreak Committees were also set-up in respective states and districts affected by the outbreak. Policies, terms of reference, roles and responsibilities of each respective ministry were drafted for smooth and co-ordinate operation. At the same time, the National Operation Room was set up and chaired by the Minister of Health to co-ordinate all the outbreak control and prevention operations. (Ministry of Health Malaysia 2001, quoted by Chua 2010).

The outbreak was contained by culling infected animals and animals from infected farms. Initially 901,228 pigs from 896 farms were destroyed in the infected areas of Perak, Negeri Sembilan and Selangor between February and April 1999, but this was stopped once an ELISA test became available to identify infected farms. A national surveillance program was then initiated over the following 3 months, and 889 farms were tested of which 50 were found to be infected and an additional 172,750 animals were culled. On average, 5.6% of all pig farms examined in peninsular Malaysia were found to be positive for Nipah virus (Nor et al 2000). There is little doubt that the outbreak was stopped by the action of culling infected animals or which came from farms where infected animals had been detected, and this had a significant effect in preventing further human infections.

As expected from its close genetic and antigenic relationship with Hendra virus, the reservoir hosts of Nipah virus were found to be Pteropid bats, especially *Pteropus hypomelanus* and *Pteropus vampyrus*. The virus was first isolated from bat urine collected from roosting *P. hypomelanus* on Tioman Island. The virus is presumed to transmit from the bats to pigs through either semi-masticated 'spats' of fruit fibres, fruit contaminated with bat saliva or bat urine. In many instances, pig farmers used fruit trees to provide shade to the pig pens as well as providing a second income, but also succeeded in bringing the bats in close proximity to the pigs, making the potential for transmission much greater. Thus control measures have focussed on keeping fruit bats away from pig pens. No new cases of Nipah infection have been detected in Malaysia since the 1999 outbreak, suggesting that the Government surveillance of pig farms and the ecological separation of the pig pens from bat roosts or trees with fruit or nectar, have been successful in reducing the potential for further cases.

The outbreak had a devastating impact on the pig industry in Malaysia, and has also caused a dramatic change in the direction of the future of the pig farming industry. About 1.1 million pigs were destroyed, which reduced the number of animals by about 50% and the number of farms was reduced from 1,885 to 829. Pig farming is now only allowed in identified specific pig farming areas, as designated by the Ministry of Agriculture, and is prohibited in previously infected areas of Negeri Sembilan. Farmers in other areas are encouraged to undertake other agricultural and livestock activities. In addition, re-stocking is subject to various controls.

Major economic costs were incurred in controlling the outbreak, in lost domestic and export markets, and in allied businesses. The Malaysian government paid USD 35 million in compensation for the 1.1 million pigs destroyed at an average price of USD 32 per pig. An estimated cost of USD 136 million was spent in the control program from the Department of Veterinary Services. Tax revenue estimated at USD 105 million was lost from the pig industry. Approximately 618 homes and 111 shops, as well as schools and banks, were evacuated in bringing the outbreak under control, causing great financial loss to the families and business involved. In addition, the pig industry in Malaysia had also provided employment to farm workers and primary supporting services like drug and vaccine sales, feed and transport, and it was estimated that 36,000 people lost their jobs due to the closure of farms (FAO, 2002). The ethnic group most affected were the Chinese as they were the major consumers of pork, with a few cases in other ethnic groups but the reasons/source for transmission to

these other groups remains undetermined in most cases. In addition, the export of pigs to Hong Kong and Singapore was halted, resulting in a loss of more than \$100 million in trade for Malaysia.

Nipah virus in Bangladesh and India. Nipah virus reappeared in 2001 causing outbreaks at Meherpur in Bangladesh and at Siliguri in West Bengal, India, although the latter was not acknowledged formally for several years. There have been about 12 outbreaks since that time, mostly in various different regions of Bangladesh, and the number of cases has exceeded 250. The outbreaks differed in several significant ways from the initial outbreak in Malaysia. There has been little involvement of pigs in most of the outbreaks in India and Bangladesh; human-to-human transmission has been reported for the first time, and accounts for over half of the cases; many of the infections have been acquired by ingestion of virus-contaminated date palm juice; the genetic diversity of virus strains indicates frequent introductions; the clinical presentation commonly includes a severe respiratory component; and the case fatality rate has almost doubled from about 40% in Malaysia to nearly 80% in Bangladesh and Malaysia (Luby et al 2009a; reviewed in Wang et al 2012). The natural reservoir of Nipah virus in Bangladesh is believed to be the fruit bat, *P. giganteus*, the only *Pteropus* species in Bangladesh.

There is still some uncertainty about the different modes of transmission of Nipah virus, but there is little doubt that human-to-human transmission occurs with evidence of nosocomial infections and clusters of cases linked to sick family members or other ill patients (Harit et al., 2006; Gurley et al, 2007), although only certain patients seem able to spread the infection (Luby et al. 2009b). Respiratory secretions appear to be particularly important for person-to-person transmission. A significant proportion of cases, particularly index cases, have implicated ingestion of raw, fresh date palm juice contaminated with virus from fruit bat saliva or urine as the probable route of transmission. Date palm juice is harvested over a relatively short period from December through March, which coincides with the seasonal incidence of Nipah infections. The palm juice or sap is collected over-night in open clay pots, and after collection, is usually turned into molasses by boiling but may also be drunk as a fresh drink within a few hours of collection. The bats are attracted to the collection vessels and attempt to lick the juice, often contaminating the juice with saliva, urine or faeces. In addition, a number of cases have been associated with other animals (cattle, pigs, and goats) or with climbing trees and possibly being exposed to contamination from bat urine or bat saliva (Luby et al, 2009a).

Prevention of Nipah virus infection is better considered in two ways – one is by limiting exposure of people to contaminated fresh date palm juice, and the other is by reducing exposure of caregivers to respiratory secretions and saliva from ill patients. For the former, it presents a dilemma - date palm sap collection provides critical income to low income collectors and is a seasonal national delicacy enjoyed by millions every year – so most effort needs to be directed at strategies to prevent the bats from gaining access to the collecting pots, and various methods are being tried, especially the use of bamboo screens or nets. For the latter, the social and cultural actions need to be addressed in a way that are consistent with the low-income setting and which help family members and other caregivers to be aware of the risks and how best to avoid or reduce them while maintaining caregiving activities.

Geographic evidence of Nipah virus and Nipah-related viruses.

Evidence of Nipah and/or Nipah-related viruses has been reported widely in southern Asia, with virus isolation from *P.vampyrus* and *P.hypomelanus* in Malaysia, from *Pteropus lylei* in Cambodia and Thailand, and from *P.giganteus* in Bangladesh., and serological or genetic evidence from *Pteropus* species in Thailand, Indonesia, China, India, Vietnam, and Madagascar. Antibodies have also been found in other fruit bats including *Cynopterus brachyotis*, *Eonycteris spelaea* and *Rousettus leschenaultia*, as well as in various *Microchiroptera* species including *Hipposideros* sp., *Scotophilus* sp., *Myotis* sp., *Miniopterus* sp. in China and Thailand. More recently, genetic evidence of Nipah-related viruses have been found in bats collected from sub-Saharan Africa in Ghana and Gabon, and also in domestic pigs in Ghana. Thus our understanding of the geographic range of the Henipaviruses, first thought to be restricted to Pteropid species of flying fox, is increasing markedly, and is

very much greater than initially thought, and in a much wider range of *Megachiroptera* and *Microchiroptera* species. The disease potential in sub-Saharan Africa and other newly recognised areas of endemicity remain to be determined, but given their virulence in southern Asia, should not be dismissed lightly, especially with the recent evidence of virus antibodies in domestic pigs in Ghana (Hayman et al, 2011).

6.7 RABIES EMERGENCY VS. ENDEMIC MANAGEMENT - LESSONS FROM INDONESIA AND AFRICA

Key messages

- Rabies is a serious endemic zoonosis in sub-Saharan Africa, and South and South East Asia with impacts on both rural and urban poor, particularly children. Its control diverts scarce veterinary and medical resources from other problems.
- Its effective management is impeded in many countries by lack of integrated medical and veterinary programs with adequate funding to carry out comprehensive mass dog vaccination, as well as to give correct treatment to people and maintain community awareness.
- The insidious nature of rabies means that new incursions are not regarded as emergencies until spread has occurred to a degree that control or elimination will be very expensive and time consuming.
- In developing countries particularly, the significant funds required to tackle rabies comprehensively are seldom prioritized compared to other greater problems. Nevertheless real economic as well as social benefits can be gained from systematic control.
- External donors with interests in animal welfare are often instrumental in trialling novel-control approaches. Mechanisms for better integrating their efforts with those of national government health and veterinary services should be further investigated.

1. Background

Rabies has a significant public health burden in many parts of the world (Knobel et al. 2005). It is usually transmitted through the bite of a rabid dog or other carnivore, and infection invariably leads to death. Although the different components of rabies control have been well understood, there are many impediments to effective control in developing countries.

One of the largest impediments to effective rabies control is the compartmentalisation of the institutions responsible for implementing its control (for example, Lembo et al 2011). Animal health institutions are usually seen to be responsible for controlling rabies in its source hosts, and rabies control often consumes large proportions of their budgets. The primary beneficiary is human health, yet rabies is rarely seen as a priority for human health institutions. Furthermore, communities themselves may have varied and changing perceptions of the importance of rabies, depending on the proximity of their exposure to cases.

2. Rabies as an endemic zoonosis

To understand and effectively control rabies requires the assimilation of several spheres of knowledge. These include the following (with reference examples mainly from sub-Saharan Africa):

- Effective on-going surveillance to monitor the dynamics of rabies outbreaks and the effect of control efforts (SEARG);
- A clear understanding of the host populations that need to be targeted for control efforts (Haydon et al. 2002; Bingham 2005);
- Current census or sample data on the maintenance host (Brooks 1990; Butler & Bingham 2000);
- Good technical knowledge of candidate animal vaccines (WHO 2005);
- Successful forums for the exchange and dissemination of information and ideas, such as the Southern and Eastern African Rabies Group (SEARG) and AfroREB; and
- Public awareness programmes that empower communities to take the lead roles in control efforts.

In addition to knowledge and information, effective strategies and skills need to be applied to control, including:-

- Effective management of funding and resourcing;
- Coherent communication of knowledge and strategies; and
- Training at a local level for the skills needed for implementing control efforts.

Vaccination-based control efforts for dog rabies in sub-Saharan Africa have, in many countries, been regular and long-term – over 60 years, in the case of Zimbabwe (Bingham et al. 1999). Success is difficult to gauge and depends on one's benchmarks. Prominent – but local and transient – reductions in disease frequency were often achieved after major vaccination campaigns (see SEARG, but note that historical documentation of many campaigns are in departmental annual reports, and are not available in the public domain). However, without extensive eradication, the disease has always returned after the host herd immunity has declined.

Rabies is also an important neglected zoonotic disease in South Asia. It is estimated that India accounts for 36% of the world's deaths from rabies (approximately 20,000 or more), with between 30% and 60% occurring in children, and most of the cases in rural areas (Lobo et al. 2011). In 2008, an Indian pilot project to prevent human rabies deaths was launched by the National Centre for Disease Control in five Indian cities, to increase awareness by the public and health care professionals about correct treatment of dog bites, but as yet there is no concerted effort to vaccinate the estimated 25 million dogs in India, although Sri Lanka and Nepal are trying to vaccinate their dog populations. While national control programs are recommended, the magnitude of the task can lead to inertia, and the effort, commitment and funding needed should not be underestimated.

3. Rabies as an emergency incursion

Flores, Indonesia Indonesia's south-eastern islands had been historically free of rabies until 1997 when a rabies-infected dog was brought by boat to eastern Flores by boat from South East Sulawesi. A policy of local stamping out by culling dogs, with no dog vaccination, was implemented. This policy (which was the national policy at the time) met great social resistance due to the cultural and economic importance of dogs to Florinese people. On Flores, dogs are eaten as a major source of animal protein, and are culturally important for ceremonial feasts at special occasions. They also assist food security by guarding mountainside crop plots, protecting them from monkeys and other wildlife, and are believed to be lucky companions protecting fishermen and others travelling at sea from drowning. The overall Florinese dog population was culled from initial 636,000 in 1997 to 170,000 by 2003; however dog smuggling and unrestrained dog movements spread rabies westwards through the whole of Flores by 2004. Despite this high culling rate, and despite provision of post-exposure prophylaxis (PEP) via local hospitals and clinics, human rabies deaths peaked at 61 in 2000, after which a changed policy of dog vaccination and only selective and targeted dog elimination was introduced. This lowered human rabies deaths to 5 - 21 per year. However, dog vaccination coverage annually is as low as 40% in some years, due to: difficulty of catching semi-wild unrestrained dogs; patchy coordination of funding from central, provincial and nine district governments for dog vaccines, operational staff, facilities and equipment; poor roads, transport, electricity and cold chain provisions throughout Flores; and ongoing mistrust between some communities and local governments due to the previous culling policy.

Applied research funded by ACIAR from 2008 - 2011 identified these and other constraints, examined the dog population dynamics on Flores, and also flagged the potential for a combined injectable / oral dog vaccination strategy to increase dog vaccination coverage and break the rabies transmission cycle. A major 3-5 year program of high coverage dog vaccination with intensive surveillance will be needed to achieve the Indonesian government's aim of rabies eradication from Flores, which will likely need donor as well as enhanced government funds, early and continued attention to community and institutional engagement and education, and means of overcoming the infrastructure and technical constraints set out above. Meanwhile, shipping and

travel between Flores and nearby islands such as Sumba and Timor, currently still rabies free, are increasing, with major risks of further rabies spread.

Bali, Indonesia In November 2008, human and canine rabies was diagnosed on the Bukit peninsula of southern Bali, and later shown to have been present since at least May 2008, probably brought in via a dog on a fishing boat from Sulawesi or Flores. Apart from sustained provision of medical services and PEP, an early attempt was made to eliminate the disease from dogs on Bali by applying the national policy (revised in the light of experience in Flores) of dog vaccination and selective and targeted dog elimination, initially on the peninsula and then in adjacent administrative districts. Emergency supplies of dog vaccine were sent to Bali by the Indonesian central government, and technical advice provided by FAO. Australian funds supported diagnostic capacity and emergency vaccination consumables, while the Bali district and provincial governments provided staff and some operational support for dog vaccination at fixed points. Due largely to under-resourcing for operational activities, this only led to 40% dog vaccination coverage in the target area by March 2009. Despite a reduced rabies attack rate, rabies outbreaks were diagnosed in further districts of Bali from August 2009, with all districts confirmed infected by mid 2010. Further Australian government assistance from late 2009 bought long-acting injectable dog vaccines and consumables as well as trialling intensive surveillance, information management and community engagement methods, but local operational funds were not sufficient during 2010 to support dog vaccination levels needed for effective control. The Bali provincial Parliament legislated for stray dog control and implemented some culling programs especially in tourist areas.

Meanwhile an outcry from animal welfare NGOs about the levels of dog culling with strychnine led to the Bali Animal welfare Association (BAWA) trialling and validating a comprehensive door- to-door dog vaccination methodology, which was then funded by the World Society for Protection of Animals (WSPA), and implemented across Bali cooperatively by Indonesian government and BAWA staff from November 2010 to April 2011. A second mass dog vaccination round using the same methods was funded and carried out by Indonesian government staff by October 2011, with coordination and training from FAO, and a third is occurring in 2012. Surveillance results will inform the need for further annual dog vaccination campaigns, but a significant decrease in rabies incidence and human deaths has already been achieved.

Each round of mass dog vaccination across Bali costs approximately US\$1million, while it is conservatively estimated that, in the three years to the end of 2011, over US\$15million was spent on human treatment after dog bites, while in this period at least 130 people died of rabies. Earlier resourcing of more comprehensive dog vaccination could have reduced the total costs and human deaths considerably.

Kwazulu Natal, South Africa In the 1970's, human rabies cases were almost eliminated from Kwazulu Natal province by regular vaccination of owned dogs and control of strays. However during the 1980's and early 1990's, the extended civil war in nearby Mozambique led to millions of refugees flocking into South Africa, many settling in rural areas and peri-urban townships outside Durban, and reintroducing rabies with their dogs. The HIV-AIDS epidemic in South Africa led to very high levels of mortality in young adults in these townships and nearby small farms, resulting by the 2000's in many child-headed families who could not care for their younger siblings let alone their dogs. Veterinary authorities were called in to shoot packs of wild dogs, which had become semi-wild and were savaging livestock and people, and discovered an alarming resurgence of rabies. A WHO program supported by the Bill and Melinda Gates Foundation (also operating in Tanzania and the Philippines) helped refocus and fund a comprehensive dog vaccination program using both injectable and oral vaccines, and in 2009 the province celebrated its first year since the 1970's without a human rabies fatality.

Overall lessons The insidious nature of rabies means that incursions are not regarded as emergencies until spread has occurred to a degree that control or elimination will be very expensive and time consuming. In developing countries particularly, the significant funds required to tackle rabies comprehensively are seldom

prioritized compared to other greater problems. Nevertheless real economic as well as social benefits can be gained from systematic control.

Lessons from recent experience are well set out by Lembo et al, (2011) who identify funding mechanisms, sustained political commitment, and community and global networking as key elements of successful approaches. These conclusions are supported by the analysis above. Considerable further research and effort is needed at international, national and sub-national levels to develop practical means to deliver these elements in different regions.

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