Food and Agriculture Organization of the United Nations

NO. 44(2)/2014

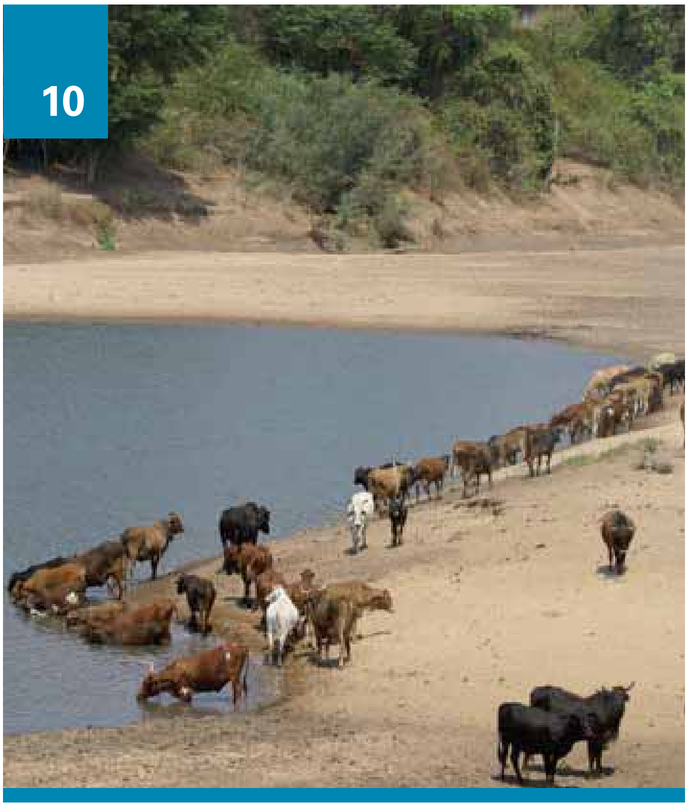
empres360 animal health

ISSN 1564-2615

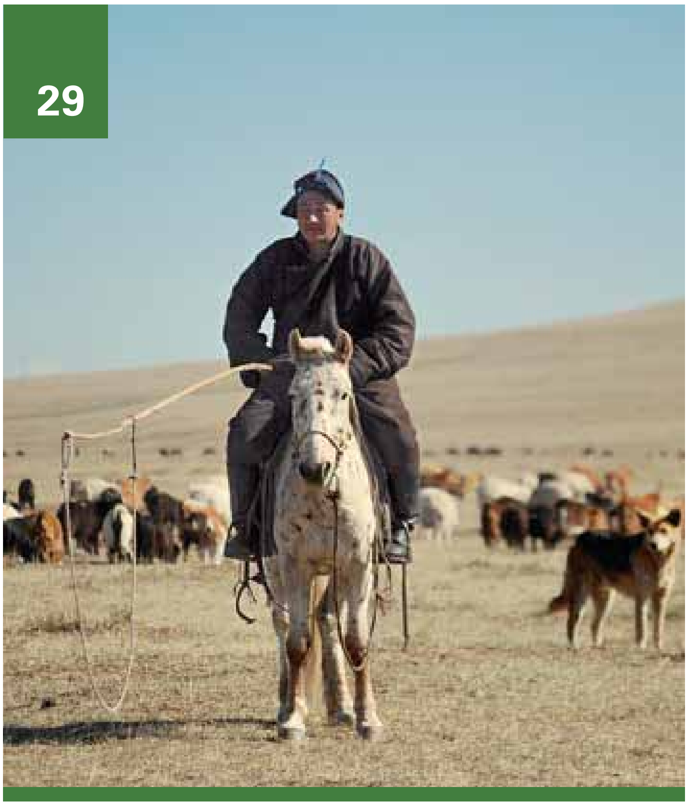
FEATURES

EMPRES-ANIMAL-HEALTH@FAO.ORG
WWW.FAO.ORG/AG/EMPRES.HTML

contents



©Alexandre Caron



©Eran Raizman

©FAO/Annibale Greco

GUEST EDITORIAL

On safeguarding animal health and livelihoods

Joseph Domenech **(OIE)**

It is a pleasure and an honour to be invited to provide a few words about this issue of the *EMPRES360 Bulletin*.

The issue presents perspectives on important diseases that are posing new emerging problems, attracting more interest for improved control or – last but not least – appearing to be rather neglected. These articles are very timely and give an excellent overview on what are more newsworthy topics than ever.

The spread of African swine fever in Europe, the periodic emergence of influenza viruses such as H7N9, and the increasing importance of peste des petit ruminants and Rift Valley fever are well-recognized threats. Some diseases can be particularly high-ranking subjects for consideration because of their potential to spread to humans (zoonotic diseases), such as those caused by certain influenza virus strains, as already mentioned, or the Middle East respiratory syndrome coronavirus disease.

The second part of this issue of *EMPRES360* explains how the Food and Agriculture Organization of the United Nations (FAO) addresses certain animal health challenges in the field involving selected diseases, groups of diseases or more complex health questions for which FAO's attention is very appropriate. The focus on diseases such as vector-borne diseases, which are evolving because of environmental changes and of which many are communicable to humans, provides good examples of the strategies and visions that FAO animal health managers and teams have chosen when defining their working priorities.

This is further illustrated by the activities FAO is carrying out in certain countries or through the organization of specialized or wider meetings. This direct involvement at the field level is a key component of FAO's mission and mandate for serving its member countries.

I would like to congratulate FAO for all the efforts being made to contribute by providing better support to countries and regions in the prevention, early detection and targeted management of animal diseases for their eventual control, in order to protect animal and human health and well-being as well as improving socio-economic development and safeguarding the livelihoods of producers, particularly poor smallholders and other stakeholders all along animal production and marketing chains. The articles presented in this *EMPRES360* issue also illustrate the range and quality of FAO's partnerships with other institutions, such as the World Organisation for Animal Health, the World Health Organization and regional organizations. This is the best way to develop holistic approaches and, in doing so, ensure improved prevention of animal health crises.360

©FAO/Giulio Napolitano

Mother, child and small ruminants

©Ministry of Agriculture and Fisheries

PERSPECTIVES

Regional Technical Consultation Meeting on Middle East Respiratory Syndrome Coronavirus (MERS-CoV) in Muscat, Oman (20–21 May 2014)

Contributors: Ahmed El Idrissi **(FAO)**, Henk Jan Ormel **(FAO)** and Juan Lubroth **(FAO)**

Middle East respiratory syndrome (MERS), a novel coronavirus (CoV) that causes a severe respiratory tract infection in humans, emerged in the Middle East region in 2012. Since then, MERS has caused 927 human infections, including 338 deaths, based on reports from the World Health Organization (WHO) as of 2 December 2014. MERS-CoV has been identified in several countries across the Middle East, Europe, North Africa and Asia, with primary infections found in Saudi Arabia, Qatar, Jordan and the United Arab Emirates.

MERS-CoV is phylogenetically related to bat CoVs, but other animal species such as dromedary camels may potentially act as intermediate hosts by spreading the virus to humans. The Food and Agriculture Organization of the United Nations (FAO) has been working with global partners to improve understanding of the role of animal species in the disease's epidemiology, the nature of the virus, and – particularly – how it spreads from its natural source to affect people.

To support these efforts, FAO convened a regional technical consultation meeting on MERS-CoV in Muscat (Oman) on 20 and 21 May 2014. The meeting was organized in close collaboration with FAO's global and regional partners and Oman's Ministry of Agriculture and Fisheries. It gathered more than 50 participants from relevant public institutions, including the directors of veterinary services of countries in the Cooperation Council for the Arab States of the Gulf (GCC), in addition to Egypt, Ethiopia, Jordan, the Sudan and Yemen; scientists from the United States Centers for Disease Control and Prevention (CDC), the University of Hong Kong and Erasmus University Medical Center in the Netherlands; representatives from the GCC Secretariat, the World Organisation for Animal Health (OIE) and WHO; and FAO staff from Headquarters, the Regional Office for the Near East and North Africa, the Subregional Office for the Gulf Cooperation Council States and Yemen (SNG) and FAO Representation in Oman.

Opening addresses were given by the Director-General of Veterinary Services at Oman's Ministry of Agriculture and Fisheries, the Subregional Coordinator of FAO SNG, and FAO's Chief Veterinary Officer (CVO). During the two days of working sessions, participants reviewed the global and regional situation of MERS-CoV and discussed technical presentations by experts from CDC, Erasmus University and the University of Hong Kong. FAO, WHO and OIE presented their activities on MERS-CoV and the main findings of joint evaluation missions conducted in countries of the region (Qatar and Saudi Arabia). During the second day, participants reviewed the current situation of MERS-CoV and case studies from participating countries.

The country and regional participants agreed on a final communiqué – the Muscat Declaration – which comprises general conclusions on the meeting's deliberations and specific recommendations for countries to step up investigations in animal species, share information, manage the risk from MERS-positive animals, and coordinate efforts to prevent the disease and curb its impact on the livestock industry. The Muscat Declaration is provided below.

The meeting was considered a timely and successful event and attracted media attention at both the national and global levels. A press release highlighting the main outcomes was posted on the FAO Web site, and interviews were given by FAO's CVO and other senior officers.

MUSCAT DECLARATION

The participants in the Regional Technical Consultative Meeting on MERS-CoV express gratitude to the Ministry of Agriculture and Fisheries, Sultanate of Oman for generously hosting this important meeting in Muscat, 20–21 May, 2014, and special thanks to his Excellency Dr Fuad Jaffer Al Sajwani, the Minister of Agriculture and Fisheries, for his continuous support and engagement to this event.

From 2012 to date, the World Health Organization (WHO) has reported a total of

©Hendrik Jan Ormel

Intense discussion during the regional technical consultation meeting on MERS-CoV organized by FAO

639 laboratory-confirmed cases of infection with the novel Middle East Respiratory Syndrome coronavirus (MERS-CoV), including 196 deaths. The majority of cases have been reported in the Kingdom of Saudi Arabia (KSA) but cases were also reported in the United Arab Emirates, Qatar, Jordan, Oman and Yemen. Imported cases have also been reported by several countries including France, Germany, Italy, Tunisia, the United Kingdom, Kuwait, Greece, the Philippines, Malaysia, Egypt, the United States of America, Lebanon and the Netherlands. Most of these infections were acquired in the Middle East and a few cases have occurred after close contact with individuals with a travel history from the Middle East.

A sharp increase in the number of human cases particularly in KSA has been recently observed. While this could represent improvements in surveillance strategies, it may be also a signal of a change in the character of the virus that would require urgent action.

Human-to-human transmission is known to occur, but other modes of transmission including from animal to human requires further exploration.

Today, a number of unanswered questions remain concerning the emergence of MERS-CoV and its mechanisms of spread. In ongoing efforts to better understand the role of animal species in the epidemiology of MERS, the Food and Agriculture Organization of the United Nations (FAO) convened a Regional Technical Consultation Meeting on MERS-CoV hosted by the Government of the Sultanate of Oman in Muscat and with the participation of the World Organisation for Animal Health (OIE) and the World Health Organization (WHO) on 20–21 May, 2014.

The meeting was opened by the Minister of Agriculture and Fisheries, His Excellency Dr. Fuad Jaffer Al Sajwani and the FAO Subregional Office Coordinator for the Gulf Cooperation Council States and Yemen and FAO Representative in UAE ad interim.

The meeting brought together over 50 participants from Bahrain, Egypt, Ethiopia, Jordan, Kuwait, Oman, Palestine, Qatar, Saudi Arabia, Sudan, United Arab Emirates, and Yemen in addition to key MERS experts from Centres for Disease Control and Prevention (Atlanta), the Erasmus Medical Center (the Netherlands), the University of Hong Kong, representatives from the Gulf Cooperation Council Secretariat, US Department of Agriculture, and other regional and national organizations. Also in attendance to the Consultative Meeting were representatives of OIE (Paris and Beirut) and WHO (Geneva) as well as staff from FAO Headquarters, Regional Office (Cairo), the sub-Regional office (Abu Dhabi) and the FAO representative in Oman.

The main objectives of this meeting were to:

- review the current state of knowledge on the disease in affected countries and the potential role of animal species in the epidemiological cycle of MERS-CoV;
- analyse the recent developments in diagnostic and surveillance tools to support animal investigations;
- identify the concrete steps and road map for coordinated actions at the regional level with a view to halt the spread of the disease; and,
- discuss and agree on mechanisms for intra-regional cooperation in investigations, research and knowledge sharing and the role of international and regional organizations.

GENERAL CONCLUSIONS[1]

Given the importance accorded to MERS-CoV in the region and around the world, the recent upsurge of human cases in the Arabian Peninsula and the suspected zoonotic transmission involving particularly dromedary camels, the participants agreed on the following statements of necessary action:

1. Prioritizing urgent investment in research and continuous and coordinated surveillance programme for MERS-CoV in animal species.
2. Strengthening joint or collaborative investigations of confirmed and probable cases through multidisciplinary teams and the systematic search for the source of infection in animals and the environment.
3. Promoting coordinated initiatives at the regional level for information sharing and joint efforts to contain the spread of the disease and to investigate the role of animal species in the epidemiology of MERS-CoV.
4. Soliciting support from the relevant international organizations and institutions and research centres to complement national efforts for the detection of the virus and the risk management of MERS-CoV.
5. Developing communication strategies to ensure appropriate information to the public on MERS-CoV and to avoid possible negative impacts of the crisis on the livestock industry.

With the overarching objectives to:

- Protect human health of MERS-CoV by reducing risk to humans from a potential animal source.
- Ensure animal health and production systems in the region are protected, to support people's livelihoods, maintain cultural values, safe trade, animal welfare, and growth of the economy.
- Provide guidance in risk analysis of MERS-CoV threats to countries in the regions of the Arabian Peninsula, Middle East, North Africa, Horn of Africa, and beyond.

The participants agreed on the following specific recommendations on *surveillance, response in the identification of a human case, research gaps, and regional cooperation*, in addition to address *best practices*:

SURVEILLANCE OF MERS-COV IN ANIMAL SPECIES

1. As required by the International Health Regulations (WHO 2005) and World Organisation for Animal Health (OIE), countries must immediately report urgent health events of epidemiological significance within their territories.
2. Joint or well-coordinated investigations should be conducted surrounding the identification of human cases that are inclusive of the environment, livestock and wildlife sectors. Such investigations should include the collection of samples for serological and viral detection (i.e., swabs, tissues) from multiple species. The composition of the investigation teams may include more than medical and veterinary specialists, as the needs require. In undertaking the investigations, systems of unique animal identification within identified barns or holdings should be operated for possible follow-up and monitoring. The samples must be appropriately labelled (species, age, sex, unique identification).
3. Attempts for virus isolation should not be undertaken in laboratories unable to ensure the laboratory safety of its personnel (below level BSL3).
4. Sero-prevalence studies for MERS-CoV are valuable to undertake risk assessment nationally and globally. The determination of high-risk areas for improved MERS-CoV management (prevalence data) could focus surveillance activities and awareness communication.
5. Promote capacity development and technology transfer to countries in need.

[1] Recognising the current understanding of the MERS-CoV virus to date and the infection/disease it causes in hosts, transmission dynamics, and pathogenesis is limited. FAO and partners will develop further guidelines as more information becomes available, through a process that includes expert consultations in science, policy and communication.

RESPONSE[2] AND RISK MANAGEMENT

1. In the context of camels suspected of having an epidemiological association with human cases, undertake serological and viral detection in multiple species (and not just focus on camels on the premises). If PCR positive animals are identified
   a. The case should be immediately reported to OIE.
   b. It is also advised that:
      i. The herd be isolated on the premises until animals are retested until PCR negative.
      ii. Milking and slaughter of positive animals for the purposes of supplying the food chain be prohibited throughout the period of isolation.
      iii. Animal products (including milk) and all bio-waste (animal faecal matter) be kept on the premises and managed effectively against pests, scavenging animals or cross-contamination
2. The response in animals/herds found to be PCR positive (without associated human cases) should be to report to public health and veterinary authorities, and if necessary PCR positive animals to be isolated and retested as above (b).
3. The response to risk associated with animal importations: any importation bans should be based on scientific evidence of positive reactivity to pathogens of concern. Until more scientific evidence on the role of animals in MERS-CoV becomes available, countries may require testing of animals prior to or at the port of entry. If animals are found PCR positive (to MERS-CoV3) then appropriate measures should be applied to reduce the risk of human exposure, including the possible isolation of positive animals until PCR negative results obtained.
4. MERS-CoV prevention in high risk environments (and specifically for slaughtering plants): Testing of animals prior to transport for slaughter and if found positive by PCR they should not be slaughtered. At slaughter plants, held animals should not be released once they have entered the facilities. *(Occupational aspects covered below)*.

RESEARCH

Research focusses on the investigation of potential routes of transmission between camels and from camels to humans.

1. An array of domestic livestock species, and if possible, wildlife species should be tested for susceptibility to MERS-CoV.
2. Longitudinal studies should be undertaken in naturally and experimentally infected camels using different age groups and production systems to determine virus shedding in excretions (nasal, fecal, milk and urine) and presence of the virus in meat and serological responses over time, to obtain more information on the natural MERS-CoV infection in dromedary camels, or other species shown to harbour MERS-CoV.
3. Further characterization of viruses identified, including viral genome sequence determination and if possible experimental infections in animal models (dromedary camels). Comparative analysis of diagnostic assays and protocols should be included.
4. Determine the possibilities to develop evidence-based intervention strategies (vaccine or other transmission prevention measures).
5. Develop field PCR assays for ease of screening and rapid risk management.
6. Characterization and mapping of animal production systems and review of specific legislation pertaining to camels and transboundary movements (racing, breeding, slaughterhouse management and compliance).

REGIONAL COORDINATION

1. The Gulf Cooperation Council (GCC) Secretariat to play an active role in coordination between the GCC countries and Regional and Sub-regional Offices of international organizations.
2. GCC Secretariat to upgrade existing GCC network on agriculture to work as information sharing platform on animal production and health (including veterinary laboratory networking)
3. Countries of the Arabian Peninsula and neighbouring countries to harmonize procedures and measures for animal movement control and border inspection to ensure safe trade of livestock.
4. Need to (re)establish a Regional Centre for Animal Health and Food Safety, which is properly resourced for its sustained function.

BEST PRACTICES - BIOSECURITY

1. The introduction of new animals into a territory should follow OIE Terrestrial Animal Health Code importation guidelines. Whenever feasible, new animals which are introduced to a territory should be individually identified prior to inclusion into herd/flock of the same species. These animals should be placed in a separate location from the existing herd and screened for the absence of infectious diseases of relevance. Farm records should be kept (and made available to competent authorities upon request).
2. Prized camels should be screened for the absence of MERS-CoV virus (PCR) or other high impact disease agents prior to gatherings (i.e., competitions or shows). The introduction of a Passport / Certificate could be instituted as a practice for movement and sanitary control.
3. Camel farm, slaughterhouse, racing and market workers should practice good personal hygiene, including frequent hand washing after touching animals, facial protection where feasible, and the wearing of protective clothing, which should be removed after work and washed daily. Workers should also avoid exposing family members to soiled work clothing, shoes, or other items that may have come into contact with camels or camel excretions. Sick animals should never be slaughtered for consumption. People should avoid direct contact with any animal that has been confirmed positive for MERS-CoV. This particularly applies to people with compromised immunity. (See: www.who.int)
4. Risk communication should be coordinated, and should include advice about risk reduction and hygiene measures, biosecurity measures, as well as conventional food safety advice particularly regarding the proper cooking of meat and only drinking milk that has been pasteurized.

ENGAGEMENT OF THE PRIVATE SECTOR

1. Engagement of the private sector (racing associations, breeding enterprises, meat packing, etc.) is strongly encouraged to ensure broad input, better communication, and compliance.

These specific interim recommendations are to be reviewed and updated as knowledge accumulates and more scientific information on MERS-CoV in animal species becomes available. They should be seen only as practical guidance to assist countries in managing animals found infected with MERS-CoV.

Dated 21 May 2014 at Muscat, Sultanate of Oman. 360

[2] Response is in reference to three scenarios (a) human case investigations with a history of physical contact with animals within the previous 30 days (acute management response). The character and nature of the contact would be part of the investigation; (b) no human case reported; and (c) animal imports.

[3] Other regulatory concerns could enter into the decision making (reactivity to other animal pathogens or welfare issues).

©FAO/Pius Ekpei

PERSPECTIVES

Regional strategy for the control of African swine fever in Africa

Contributors: Hiver Boussini **(AU-IBAR)**, Daniel Beltran-Alcrudo **(FAO)**, Cheikh Ly **(FAO)**, Edward Okot **(ILRI)**, Sam Okuthe **(FAO)**, Zelalem Tadesse **(AU-IBAR)**, Berhanu Bedane **(FAO)**, Bouna Diop **(FAO)** and Baba Soumaré **(AU-IBAR)**

BACKGROUND AND RATIONALE

The African Union's Interafrican Bureau for Animal Resources (AU-IBAR), the Food and Agriculture Organization of the United Nations (FAO) and the International Livestock Research Institute (ILRI) have jointly developed a regional strategy for the control of African swine fever (ASF) in Africa.

ASF can cause up to 100 percent mortality in domestic pigs. Almost half of African countries (25 countries) reported the disease in 2012 (Figure 1). As well as causing major economic losses from its devastating effects on pig production, ASF also has a considerable social impact because of the resulting food insecurity, rural poverty and overall development constraints for people who depend on pig farming (e.g. loss of employment, and loss of access to high-quality and cheap animal protein for poor communities). In addition, pigs are an important household asset that can be converted into cash when needed.

Because of these features, ASF is considered the most serious infectious disease

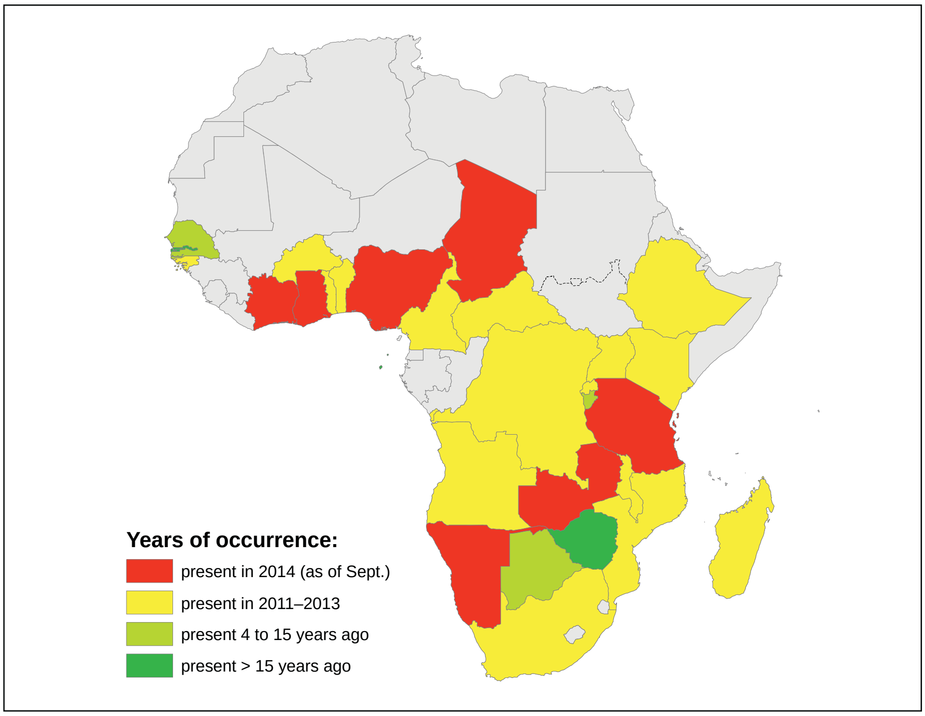


Figure 1: Geographical distribution of African swine fever in Africa
Source: FAO and OIE/WAHID

©Hiver Boussini

Example of a pig production system found in Chad and many other African countries

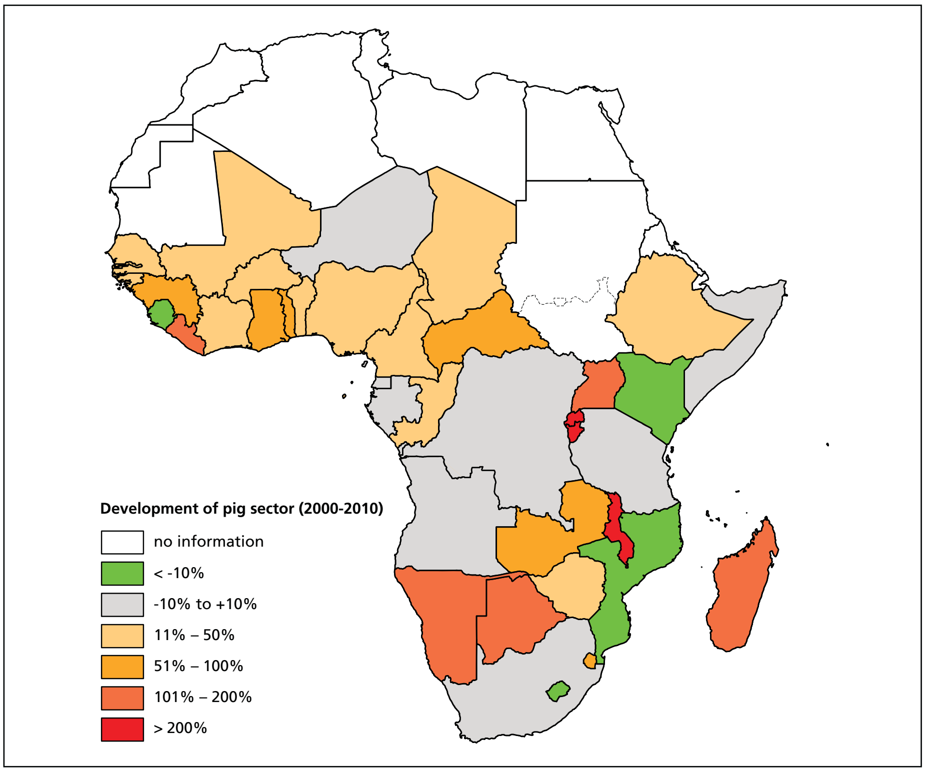


Figure 2a: Geographical distribution of African swine fever in Africa
Source: FAO and OIE/WAHID.

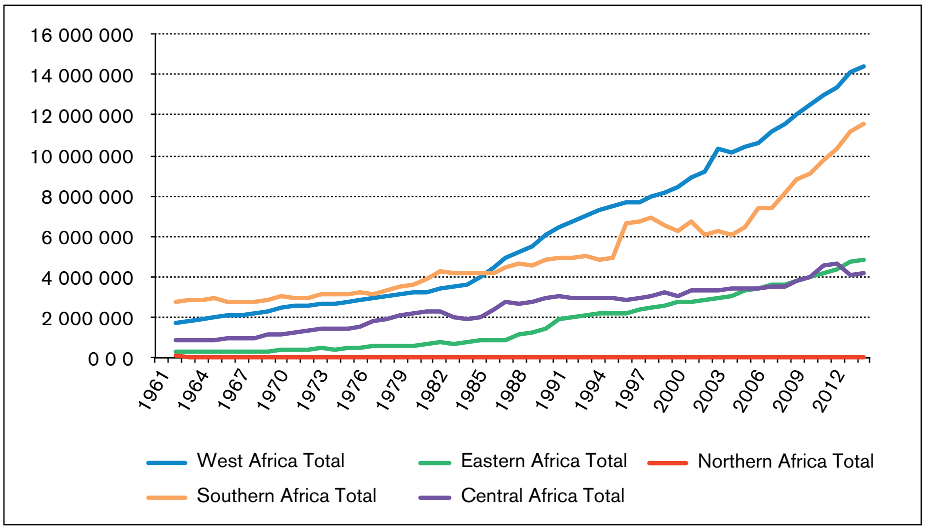


Figure 2b: Growth in subregional pig populations in Africa, 1961–2012
Source: FAOSTAT.

of pigs in Africa and an important constraint to development. There is increased commitment among national authorities, the international community, the pig production sector and researchers to solving the ASF problem sustainably. However, effective intraregional cooperation on the control of animal diseases across Africa is lacking. The development and implementation of a regional strategy for the prevention and control of ASF in Africa is therefore crucial and urgent. The proposed strategy will constitute a milestone in the fight against ASF and will provide the framework for cooperation. It is based on enhanced collaboration and partnerships among farmers, traders, veterinary and animal production services, researchers, governments, civil society and development partners.

Pork production and consumption are increasing in many African countries. Pig farming is an attractive venture for smallholders because of pigs' ability to convert agro-industrial by-products and household waste into quality animal protein, and because of their short production cycle and high prolificacy and carcass yield compared with those of ruminants. As a result, the importance of pigs as a source of food and income generation is growing fast, as reflected in the dynamics of the pig sector in Africa.

During the last decade, the pig population of sub-Saharan Africa has experienced rapid but uneven growth (Figure 2a). Currently, the pig sector in Africa totals 34.2 million head and official figures count 1.2 million tonnes of pork production a year even though most pigs are not slaughtered in abattoirs; pigs are unevenly distributed across sub-Saharan Africa, with negligible production in North Africa (Figure 2b).

The pig sector in Africa is dominated by small-scale scavenging (extensive) pig production systems, characterized by minimum investment in inputs, housing and distribution. Very little intensive and semi-intensive farming of exotic bred pigs is practised. The small-scale husbandry of local breeds is common and depends on low-quality feeds such as crop residues, household waste and grass.

Although local breeds are sturdy and well adapted to the environment, they are characterized by small size, low growth performance and small litter size. Improved knowledge and husbandry practices spread slowly because of the generally weak extension services, while viral diseases such as ASF and foot-and-mouth disease, and parasitoses such as trichinellosis and cysticercosis further lower the sector's productivity. Improvement in genetics, feeding, health, husbandry practices, organization/logistics and marketing is the key to further development of the pig sector.

APPROACH AND COMPONENTS OF THE REGIONAL STRATEGY

THE PROCESS

A task force composed of representatives from AU-IBAR, FAO and ILRI was established in March 2013 to draft the strategy through an iterative process, taking into account lessons learned and recommendations from three ASF subregional meetings held in N'Djamena (Chad, Central Africa), Mombasa (Kenya, East Africa) and Accra (Ghana, West Africa). The resulting draft strategy was reviewed and consolidated with comments and inputs provided by peer reviewers from research institutions, national veterinary services and partner organizations. The strategy is expected to be presented for validation and endorsement to African stakeholders in the near future.

STRATEGIC APPROACH

The shared vision behind the strategy is of an Africa where ASF no longer constrains sustainable pig production and rural development, or threatens livelihoods. The control of ASF will contribute to food security, livelihoods, poverty alleviation and wealth creation throughout the region.

This vision guided the development of a consistent, cohesive and coordinated response plan focusing on the overall goal of reducing the impact of ASF on the pig sector in Africa, thereby: i) promoting viable pig production; and ii) improving the livelihoods of all actors in the pig and pork value chains, especially poor people.

The two specific objectives of the strategy for Africa are to: i) control ASF in infected countries; and ii) prevent the introduction of ASF into non-infected countries.

The regional strategy should ultimately guide programmes and projects to achieve the following outputs:

- understanding of the epidemiology of ASF and the socio-economic drivers of ASF status, spread, prevention and control;
- enhanced awareness and reporting of ASF by farmers, traders, butchers and other stakeholders in the pig sector;
- strengthened capacities of veterinary services in disease recognition, diagnosis, surveillance, management, contingency planning and emergency response, and risk analysis;
- reduced prevalence and impact of ASF;
- improved performance and biosafety of pig and pork value chains.

The strategy applies an approach based on three founding principles:

- It is *knowledge-based.* Control of ASF should be based on the best available epidemiological and socio-economic knowledge and experiences and on optimal preparedness, to reduce prevalence and prevent further spread of ASF, recognizing that eradication may not be possible in the current African context.
- It is *area-specific.* Responding to ASF entails: i) addressing country- and sector-specific epidemiological scenarios and technical options for prevention and control; ii) developing regional and national capacities to monitor the disease situation and implement and maintain prevention and control options; and iii) providing sustainable, technically sound and socially equitable support to control ASF.
- It is *holistic.* As the predominant pig production and marketing system in Africa is conducive to rapid transmission and spread of the disease, the strategy promotes gradual transformation of the less biosecure, small-scale, scavenging production system into a more biosecure, small-scale, semi-intensive production system. The strategy also promotes biosecurity in existing semi-intensive and intensive production systems. Improved biosecurity requires integration of the traditional veterinary approach with other components of animal production (genetics, nutrition, husbandry, market chains, etc.) and with other less traditional disciplines related to socio-economics, environmental sciences, etc.

COMPONENTS OF THE REGIONAL STRATEGY

The different components of the regional strategy can be grouped into the three principles/pillars described in the previous section:

- Providing the knowledge base:
  - collection, collation and analysis of existing information relevant to epidemiology and control;
  - surveillance to provide up-to-date information about the ASF situation in the region;
  - increased capacity for field diagnosis through training, information dissemination and improved/optimized laboratory diagnostic capacity in the region;
  - research in:
    - **i.** pig management;
    - **ii.** value chain analysis, risk assessment, identification of critical control points and development of mitigation measures;
    - **iii.** molecular epidemiology studies, diagnosis and vaccine development.
- Developing area- and system-specific plans for preventing/managing ASF:
  - facilitation of development and organization of the pig sector;
  - biosecurity for different types of production systems;
  - awareness raising and communication;
  - appropriate outbreak management for different systems and socio-economic scenarios.
- Holistic transformation of the pig sector to improve livelihoods and manage diseases:
  - harmonization of policy and legislation;
  - coordination, partnerships and resource mobilization.

CONCLUSIONS

This regional strategy needs to be translated into a concrete action plan, especially at the level of value chain actors and veterinary services. Such an action plan will articulate the short-, medium- and long-term streams of activities, and identify the stakeholder(s)/institution(s) responsible for each activity. The formulation of a regional strategy is a fundamental step that needs to be accompanied by an evidence-based approach with an appropriately designed control programme to achieve the outputs listed in the previous section. Development of the pig sector depends highly on creating an enabling environment whereby stakeholders participate in solutions that address the main constraints faced in pig production and marketing. In addition, the research community should provide sound evidence to inform prevention and control programmes about viable interventions. Constraints in pig production are interrelated and need to be addressed via an integrated approach combining health, genetics, feeding, husbandry practices and organization at the producer level, as well as public and private partnerships to support the swine sector. 360

Leopold Mulumba, Director of Central Veterinary Laboratory of Kinshasa, Democratic Republic of the Congo, 2011

Pig transport in rural Africa

©Alexandre Caron

PERSPECTIVES

Bovine tuberculosis: a double-edged issue at the human/livestock/wildlife interface in Africa

Contributors: Alexandre Caron **(CIRAD[1], RP-PCP[2]),** Michel de Garine-Wichatitsky **(CIRAD, RP-PCP)** and François Roger **(CIRAD)**

BOVINE TUBERCULOSIS IN AFRICA

Bovine tuberculosis (bTB) caused by *Mycobacterium bovis* is a major neglected tropical disease and there are important gaps in understanding of the epidemiology of this animal disease and zoonosis (Hotez and Kamath, 2009; El Idrissi and Parker, 2012). Its impacts can be economic, as bTB decreases the level of livestock production for both local and export markets; sanitary, as bTB can be transmitted from animal to human populations, causing severe disease and mortality; social, when livestock ownership is a source of social status in rural communities; and detrimental to biodiversity conservation, when bTB threatens wildlife populations or when disease management options consider the possibility of wildlife control. In developed countries, although bTB was once thought to be under control, the disease is re-emerging as a result of maintenance of the agent in new wild host species. In the developing world, bTB is widespread in animal populations, and the animal and human health surveillance systems are not adapted to detect the infection efficiently or to assess its real impact on both host populations (Thoen *et al.,* 2009).

In Africa, the epidemiological situation of bTB in livestock and human populations is highly variable. In many cattle populations, the disease is chronic and largely asymptomatic until latter stages of disease. There is little information about the disease in small ruminants; although recent studies have indicated that goats in Africa are more prone to *Mycobacterium tuberculosis* infection than to bTB (Deresa, Conraths and Ameni, 2013), bTB is known to occur in goats in Europe (Napp *et al.,* 2013). Small ruminants could therefore be an important host for the spillover of *M. tuberculosis* to humans and vice versa. The extent of this spillover is unknown because of the lack of local diagnostic capacity to detect extra-pulmonary tuberculosis (TB), the major form of bTB in humans (Durr *et al.,* 2013); the few studies providing information on this aspect indicate absence (Tschopp *et al.,* 2010) or low prevalence of bTB in humans (Thoen *et al.,* 2009). The implications of a high prevalence of human immunodeficiency virus (HIV) for bTB susceptibility and prevalence in African rural populations are also largely unexplored, and human behaviour such as raw milk consumption can be an important additional risk factor. The high mammal diversity that still occurs in some areas of Africa provides additional hosts for *M. bovis*. In the Great Limpopo Transfrontier Conservation Area (GLTFCA) of southern Africa, for example, bTB has been shown to occur in more than 16 wild species (A.L. Michel, pers. comm.), but the role of each species in maintaining the

©Alexandre Caron

Cattle owner and herd in the Zinder area of the Niger, 2006

[1] International Cooperation Centre of Agricultural Research for Development: www.cirad.fr
[2] Research Platform Production and Conservation in Partnership: www.rp-pcp.org

disease is unknown or still debated, as are the impacts of the disease on different species.

The spatial extent and intensity of wildlife/livestock/human interfaces in Africa are highly variable. Interface areas range from double fences separating conservation areas (e.g. national parks) from other land-use types (e.g. communal land), to integrated mixed systems where wildlife and livestock production coexist (e.g. tourism and meat production). Some interface areas are marked by porous physical barriers, which can take the form of buffer zones around wildlife conservation areas, where human activities are regulated (e.g. wildlife hunting concessions), or environmental land-use boundaries such as rivers, which can attract wild and domestic ungulates and facilitate interactions (Kock *et al.,* 2014). Many of these interface areas share important characteristics: they occur in semi-arid and arid areas where poor human communities with little access to human and animal health services struggle to make a livelihood from small-scale farming, environmentally constrained cultivation and the legal or illegal harvesting of natural resources (Giller *et al.,* 2013). Limited availability of resources such as water and grazing land, especially during the dry season, promotes interactions among wildlife, livestock and human populations, increasing the risk of pathogen transmission. There is potential for these interface areas to play an important role in the epidemiology of bTB in Africa.

Across Africa, these interfaces span large tracts of land, but regional differences can arise as a result of historical and political contingencies. In western Africa, wildlife has been largely extirpated and its role in the epidemiology of bTB is probably very limited because the interface with livestock is localized around a few remaining wildlife conservation areas. In this region, *M. bovis* is therefore maintained mostly in livestock populations.

In central Africa, forest environments do not provide opportunities for intense contacts between wildlife and livestock species because forage resources are widely distributed and freely available. Although few data are available, it seems likely that these limited interface areas do not play an important role in bTB epidemiology.

In eastern Africa, *M. bovis* is endemic in wild and domestic ungulate populations (Tschopp *et al.,* 2010), but its epidemiology in the region's ecosystems has not attracted much interest until recently (e.g. Tschopp *et al.,* 2010; Roug *et al.,* 2014) and many gaps in knowledge remain. Eastern Africa has conserved extensive wildlife populations and several countries rely heavily on the wildlife industry for tourism. Expanding pastoral and agropastoral human populations in dry savannahs encroach increasingly on to natural areas, but overall densities of wildlife and livestock are relatively low, except in areas of Ethiopia, where there are large cattle and wild ungulate populations.

In southern Africa, bTB at wildlife/livestock interfaces has been the focus of several studies, probably because the pathogen was introduced and spread in the Kruger National Park ecosystem in South Africa, where the implications for the conservation of wildlife mobilized the scientific community. Interface areas in southern Africa include fenced areas (e.g. Kruger National Park or country-wide fenced systems in Namibia and Botswana) and unfenced boundaries on the periphery of conservation areas. Recent initiatives to create transfrontier conservation areas in this region have drawn attention to the human and animal health issues associated with these complex socio-ecosystems (Osofsky, Cumming and Kock, 2008). The disease is spreading in some regions of southern Africa, and is endemic in others, with livestock/wildlife interfaces playing an important role in the inter-species spillover and spread of the pathogen.

> "In the developing world, bTB is widespread in animal populations, and the animal and human health surveillance systems are not adapted to detect the infection"

THE ECOLOGY OF bTB IN MULTI-HOST SYSTEMS IN AFRICA

At wildlife/livestock interfaces, bTB evolves in complex multi-host systems. Each wild or domestic host can play an epidemiological role in the maintenance and spread of the pathogen, and lack of understanding of these roles can compromise the success of control strategies. Implementing a test-and-slaughter strategy in livestock populations will fail if a wild maintenance host repeatedly reintroduces the infection into the domestic animal population. Similarly, failure to understand the role of small ruminants in bTB or TB epidemiology can compromise control measures in cattle and human infection. Adopting a more functional approach to identify the key hosts in disease epidemiology has been proposed as a way of improving knowledge of – and therefore surveillance and control strategies for – infectious diseases in Africa, including emerging diseases (Caron, Morand and Garine-Wichatitsky, 2012).

In South Africa, cattle imported from Europe have been retrospectively identified as the source of bTB. In the 1950s and 1960s, cattle from farms neighbouring the southern boundary of the Kruger National Park acted as a source of bTB for wildlife in the park when bTB spilled over to African buffalo (*Syncerus caffer*). Since then, *M. bovis* has spread in wildlife populations, reaching the northern tip of the park in 2005 and emerging in a buffalo population in the Gonarezhou National Park in Zimbabwe, despite the 40 km of communal land separating the two parks (de Garine-Wichatitsky *et al.,* 2010; Kock *et al.,* 2014). Molecular studies indicate that buffaloes, and probably greater kudus (*Tragelaphus strepsiceros*), have become maintenance hosts for bTB in this ecosystem (Michel *et al.,* 2009), although buffaloes do not seem to be clinically affected by *M. bovis* infection. It is suspected that most other wild species act as dead-end hosts, i.e. they can be infected by bTB but do not pass it on to other animals, although the effects at the species level can be severe. For example, bTB seems to be relatively aggressive in the lion population via consumption of infected buffaloes, with potential consequences on the tourism industry, for which the lion is a key species. Recent studies have collected more information on the presence of bTB at other cattle/buffalo interfaces in southern Africa (Jori *et al.,* 2013; Tanner *et al.,* 2014). In this region, the lechwe kob (*Kobus leche kafuensis*) has also been shown to maintain bTB close to wildlife/livestock interfaces in Zambia (Munyeme *et al.,* 2010).

As well as the biodiversity conservation issues related to the spread of bTB in wildlife populations, another important issue is the risk of spillback of bTB from a wildlife reservoir to naive cattle populations. The emergence of bTB in the buffalo population of the Gonarezhou National Park in Zimbabwe underlines the threat of such spillback, and also of spillover to human populations, directly through bushmeat consumption or indirectly through cattle or goats (de Garine-Wichatitsky *et al.,* 2010; Caron *et al.,* 2013). The buffalo population in GLTFCA could become a spatial vector, acting as a host population bridging cattle populations in South Africa and Zimbabwe. While spillback of bTB from a wildlife maintenance host to a domestic host seems to be rare in Africa (de Garine-Wichatitksy *et al.,* 2013a), recent studies suggest that it is possible (Munyeme and Munang'andu, 2011; Musoke *et al.,* 2013).

These studies underline the complex epidemiology of bTB at the wildlife/livestock interface and the need to disentangle the role of each host to understand the


© Alexandre Caron

Cattle herds drinking at a Mwenezi River pool during the dry season. On one side of the river is Gonarezhou National Park, on the other, Malipati communal land, 2008


© Alexandre Caron

Buffaloes on the run in Gonarezhou National Park, Zimbabwe. The species has the capacity to move undetected into anthropogenized land, triggering potential for bTB spillover from wildlife to cattle, 2008

pathogen dynamics in socio-ecosystems. The risk of bTB transmission between wild and domestic species, and ultimately to humans, is documented, but questions remain regarding the sanitary, economic and social consequences of the disease.

BOVINE TUBERCULOSIS – A NEGLECTED TROPICAL DISEASE OR NOT A PROBLEM?

Estimating the impacts of bTB on human, livestock and wildlife populations is difficult because of the chronic form of the disease. In western and eastern Africa, although bTB is endemic in cattle populations, animal and public health authorities do not consider it a priority disease. The lack of diagnostic capacities to differentiate *M. bovis* in humans from the human pathogen *M. tuberculosis* blurs the impact of bTB on human populations. A more relevant question concerns the *relative* impact of bTB in its hosts, as most hosts harbour communities of pathogens that can have impacts on their health and production (Caron *et al.,* 2013). Small-scale farming communities would probably rank bTB below tick-borne diseases and other more deadly diseases of their livestock (de Garine-Wichatitksy *et al.,* 2013b), while veterinary services generally prioritize diseases with high economic impacts, such as foot-and-mouth disease, and largely ignore bTB. In addition to descriptive epidemiology of bTB in African contexts, three areas of research could help decision-makers to assign appropriate priority to bTB surveillance or control:

- *Impact of bTB on human and animal populations:* What are the health and production consequences of having endemic bTB in host populations? While the impact of bTB in cattle populations in the northern hemisphere has been documented, little information is available on African contexts (Mwacalimba, Mumba and Munyeme, 2012). Notably, the interplay among bTB, the immune system and other diseases (e.g. brucellosis, Rift Valley fever, tick-borne diseases) could increase the overall disease burden in host populations (e.g. Ezenwa *et al.,* 2010).

> "In western and eastern Africa, although bTB is endemic in cattle populations, animal and public health authorities do not consider it a priority disease"

- *Understanding bTB at human/livestock/wildlife interfaces:* Studying the relationship between the type of host contact and pathogen transmission could help identify the types of interface, seasons and drivers of host contact leading to bTB spillover/spillback, which will be specific to local contexts (e.g. Miguel *et al.,* 2013). Detailed ecological and social studies would be required to identify the relevant risk factors.
- *Diagnostic tools:* The development of bTB diagnostic tools adapted to wildlife, livestock and human hosts could help improve field detection and discrimination between bTB infection and the presence of other mycobacteria (Chambers, 2013). A recent study investigating the relationship between the presence of *Fasciola haepatica* and bTB diagnosis in cattle in the United Kingdom of Great Britain and Northern Ireland highlights the need to investigate the effect of multi-pathogen conditions on bTB diagnostic sensitivity (Claridge *et al.,* 2012).

TRANSLATING RESEARCH INTO MANAGEMENT AND CONTROL OPTIONS

For countries prioritizing bTB, research on bTB epidemiology at wildlife/livestock/human interfaces can have a positive influence on surveillance and control, as surveillance systems need to be adapted to the specific situations of these interfaces. In multi-host systems, research can identify which host(s) should be sampled to detect the pathogen or to estimate its prevalence cost-effectively. Optimizing surveillance systems at these interfaces – including by taking advantage of local opportunities such as surveillance on bush meat and hunted wildlife – and adapting them to the multi-pathogen context will increase the efficiency of veterinary services in resource-limited environments. The integration of heterogeneous data from surveillance into risk analysis tools can facilitate estimation of the risk of spillover and/or spread between susceptible host populations (Etter *et al.,* 2006). Research can also help prevent disease spillover/spillback into new host populations by offering management options for human/livestock/wildlife interfaces.

Decreasing contacts between infected and naive hosts will limit the local spread of bTB, so adapted farming practices such as reducing the shared use of pasture and water by wild and domestic ungulates can be explored when the risk of contact is understood in the local spatio-temporal context (e.g. whether it is based on hotspots of transmission or seasonal risk of contacts). When bTB is endemic in host populations, its control or eradication is difficult, and it may be necessary to learn to live with the infection. In an endemic situation, management options will need to be identified for reducing the impact of bTB on livestock and wildlife host populations in a multi-pathogen context, and for minimizing human exposure to the pathogen. Collaboration with farmers, local veterinary services, wildlife managers and the public health sector should result in the design of socio-economically acceptable sanitary management plans to promote sustainable livestock production in African contexts. For example, the zoonotic transmission can be greatly reduced by implementing basic hygiene measures if acceptable for local traditions (e.g. boiling milk). The impact of bTB in production animals needs to be assessed: does bTB really have an impact on local production (i.e. is bTB a priority disease for local farmers?). There is room for participatory approaches that merge distinct spheres of knowledge, bringing scientific information to local communities and translating communities' knowledge into information for the scientific community to come up with appropriate and locally acceptable control or management measures.

The situation of bTB at human/livestock/wildlife interfaces is complex and can only be tackled through interdisciplinary approaches that bridge epidemiology, ecology, economics and social sciences, as recommended by the One Health and EcoHeath approaches (Pfeiffer, 2013). These approaches should aim at reducing the risk of bTB spillover to important populations, and reducing the impact of the disease on animal and humans. 360

REFERENCES

Caron, A., Morand, S. & Garine-Wichatitsky, M. 2012. Epidemiological interaction at the wildlife/livestock/human interface: Can we anticipate emerging infectious diseases in their hotspots? A framework for understanding emerging diseases processes in their hot spots. *In* S. Morand, F. Beaudeau and J. Cabaret (eds). *New frontiers of molecular epidemiology of infectious diseases,* pp. 311–332. Dordrecht, Netherlands, Springer.

Caron, A., Miguel, E., Gomo, C., Makaya, P., Pfukenyi, D.M., Foggin, C., Hove, T. & de Garine-Wichatitsky, M. 2013. Relationship between burden of infection in ungulate populations and wildlife/livestock interfaces. *Epidemiol Infect.,* 141(7): 1522–1535.

Chambers, M.A. 2013. Review of the diagnosis of tuberculosis in non-bovid wildlife species using immunological methods – an update of published work since 2009. *Transbound. Emerg. Dis.,* 60(Suppl 1): 14–27.

Claridge, J., Diggle, P., McCann, C.M., Mulcahy, G., Flynn, R., McNair, J., Strain, S., Welsh, M., Baylis, M. & Williams, D.J.L. 2012. *Fasciola hepatica* is associated with the failure to detect bovine tuberculosis in dairy cattle. *Nature Communications,* 3: article 853.

de Garine-Wichatitsky, M., Caron, A., Gomo, C., Foggin, C., Dutlow, K., Pfukenyi, D., Lane, E., Le Bel, S., Hofmeyr, M., Hlokwe, T. & Michel, A. 2010. Bovine tuberculosis in buffaloes, Southern Africa. *Emerg Infect Dis.,* 16(5): 884–885.

de Garine-Wichatitksy, M., Caron, A., Kock, R., Tschopp, R., Munyeme, M., Hofmeyr, M. & Michel, A. 2013a. A review of bovine tuberculosis at the wildlife-livestock-human interface in sub-Saharan Africa. *Epidemiol Infect.,* 141(7): 1342–1356.

de Garine-Wichatitksy, M., Miguel, E., Mukamuri, B., Garine-Wichatitksy, E., Wencelius, J., Pfukenyi, D.M. & Caron, A. 2013b. Coexisting with wildlife in transfrontier conservation areas in Zimbabwe: cattle owners' awareness of disease risks and perceptions of the role played by wildlife. *Comp Immunol Microbiol Infect Dis.,* 36(3): 321–332.

Deresa, B., Conraths, F.J. & Ameni, G. 2013. Abattoir-based study on the epidemiology of caprine tuberculosis in Ethiopia using conventional and molecular tools. *Acta Vet Scand.,* 59: 15.

Durr, S., Müller, B., Alonso, S., Hattendorf, J., Laisse, C.J., van Helden, P.D. & Zinsstag, J. 2013. Differences in primary sites of infection between zoonotic and human tuberculosis: results from a worldwide systematic review. *PLoS Negl. Trop. Dis.,* 7(8): e2399.

El Idrissi, A. & Parker, E. 2012. Bovine tuberculosis at the animal–human–ecosystem interface. *EMPRES Transboundary Animal Diseases Bulletin, 40*: 2–11.

Etter, E., Donado, P., Jori, F., Caron, A., Goutard, F. & Roger, F. 2006. Risk analysis and bovine tuberculosis, a re-emerging zoonosis. *Annals of the New York Academy of Sciences,* 1081: 61–73.

Ezenwa, V.O., Etienne, R.S., Luikart, G., Beja-Pereira, A. & Jolles, A. 2010. Hidden consequences of living in a wormy world: nematode-induced immune suppression facilitates tuberculosis invasion in African buffalo. *Am. Nat.,* 176(5): 613–624.

Giller, K.E., Baudron, F., Matema, S., Milgroom, J., Murungweni, C., Guerbois, C. & Twine, W. 2013. Population and livelihoods on the edge. *In* J.A. Andersson, M. de Garine-Wichatitsky, D.H.M. Cumming, V. Dzingirai and K.E. Giller (eds). *Transfrontier conservation areas: people living on the edge,* pp. 62–88. London, Earthscan from Routledge.

Hotez, P.J. & Kamath, A. 2009. Neglected tropical diseases in sub-Saharan Africa: review of their prevalence, distribution, and disease burden. *PLoS Neglected Tropical Diseases,* 3(8): e412.

Jori, F., Mokospasetso, M., Etter, E., Munstermann, S., Newman, S.H. & Michel, A. 2013. Preliminary assessment of bovine tuberculosis at the livestock/wildlife interface in two protected areas of northern Botswana. *Transbound. Emerg. Dis.,* 60(Suppl. 1): 28–36.

Kock, R., Kock, M., de Garine-Wichatitksy, M., Chardonnet, P. & Caron, A. 2014. Livestock and buffalo (*Syncerus caffer*) interfaces in Africa: ecology of disease transmission and implications for conservation and development. *In* M. Melletti and J. Burton (eds). *Ecology, evolution and behaviour of wild cattle: Implications for conservation,* pp. 431–445. Cambridge, UK, Cambridge University Press.

Michel, A.L., Coetzee, M.L., Keet, D.F., Maré, L., Warren, R., Cooper, D., Bengis, R.G., Kremer, K. & van Helden, P. 2009. Molecular epidemiology of *Mycobacterium bovis* isolates from free-ranging wildlife in South African game reserves. *Vet. Microbiol.,* 133(4): 335–343.

Miguel, E., Grosbois, V., Caron, A., Boulinier, T., Fritz, H., Cornélis, D., Foggin, C., Makaya, P.V., Tshabalala, P.T. & de Garine-Wichatitsky, M. 2013. Contacts and foot and mouth disease transmission from wild to domestic bovines in Africa. *Ecosphere,* 4(4): article 51.

Munyeme, M. & Munang'andu, H.M. 2011. A review of bovine tuberculosis in the kafue basin ecosystem. *Vet. Med. Int.,* 2011: 918743.

Munyeme, M., Muma, J.B., Siamudaala, V.M., Skjerve, E., Munang'andu, H.M. & Tryland, M. 2010. Tuberculosis in Kafue lechwe antelopes (*Kobus leche Kafuensis*) of the Kafue Basin in Zambia. *Prev. Vet. Med.,* 95(3-4): 305–308.

Musoke, J., Hlokwe, T., Marcotty, T. & Michel, A.L. 2013. The prevalence of bovine tuberculosis in cattle at the wildlife/livestock/human interface in the Mnisi community, South Africa. 14th International Conference of the Association of Institutes of Tropical Veterinary Medicine, 25–29 August 2013, Johannesburg, South Africa.

Mwacalimba, K.K., Mumba, C. & Munyeme, M. 2012. Cost benefit analysis of tuberculosis control in wildlife–livestock interface areas of southern Zambia. *Prev. Vet. Med.,* 110(2): 274–279.

Napp, S., Allepuz, A., Mercader, I., Nofrarias, M., López-Soria, S., Domingo, M., Romero, B., Bezos, J. & Pérez de Val, B. 2013. Evidence of goats acting as domestic reservoirs of bovine tuberculosis. *Veterinary Record,* 172(25): 663.

Osofsky, S.A., Cumming, H.M. & Kock, M.D. 2008. Transboundary management of natural resources and the importance of a "One Health" approach. *In* E. Fearn for the Wildlife Conservation Society (ed.). *2008–2009 State of the Wild: A global portrait of wildlife, wildlands, and oceans,* pp. 89–98. Washington, DC, Covelo, California, USA and London, Island Press.

Pfeiffer, D.U. 2013. Epidemiology caught in the causal web of bovine tuberculosis. *Transbound. Emerg. Dis.,* 60(Suppl. 1): 104–110.

Roug, A., Clifford, D., Mazet, J., Kazwala, R., John, J., Coppolillo, P. & Smith, W. 2014. Spatial predictors of bovine tuberculosis infection and *Brucella* spp. exposure in pastoralist and agropastoralist livestock herds in the Ruaha ecosystem of Tanzania. *Trop. Anim. Health Prod.,* 46(5): 837–843.

Tanner, M., Inlameia, O., Michel, A., Maxlhuza, G., Pondja, A., Fafetine, J., Macucule, B., Zacarias, M., Manguele, J., Moiane, I.C., Marranangumbe, A.S., Mulandane, F., Schönfeld, C., Moser, I., van Helden, P. & Machado, A. 2014. Bovine tuberculosis and brucellosis in cattle and African buffalo in the Limpopo National Park, Mozambique. *Transbound. Emerg. Dis.,* doi:10.1111/tbed.12210.

Thoen, C.O., Lobue, P.A., Enarson, D.A., Kaneene, J.B. & de Kantor, I.N. 2009. Tuberculosis: a re-emerging disease in animals and humans. *Vet. Ital.,* 45(1): 135–181.

Tschopp, R., Aseffa, A., Schelling, E., Berg, S., Hailu, E., Gadisa, E., Habtamu, M., Argaw, K. & Zinsstag, J. 2010. Bovine tuberculosis at the wildlife-livestock-human interface in Hamer Woreda, South Omo, Southern Ethiopia. *PLoS One,* 5(8): e12205.

©FAO/Sarah Elliott

PERSPECTIVES

Spatial multi-criteria evaluation: a promising methodology for identifying areas at risk of Rift Valley fever

Contributors: Véronique Chevalier **(CIRAD AGIRs Unit)**, Carlène Trevennec **(FAO)**, Marie Gély **(CIRAD AGIRs Unit)**, Julio Pinto **(FAO)** and Annelise Tran **(CIRAD AGIRs Unit)**

Rift Valley fever (RVF), caused by a *Phlebovirus* (*Bunyaviridae*), is considered one of the most important viral zoonoses in Africa, affecting both livestock and humans (Pépin *et al.,* 2010). The virus is transmitted: i) between ruminants, by mosquitoes and perhaps by direct contact with viraemic blood, abortion products or other excretions and secretions from viraemic animals (Nicolas *et al.,* 2014); and ii) from ruminants to humans, by direct and mosquito-borne routes (Pépin *et al.,* 2010).

The health and economic consequences of RVF outbreaks are severe. In ruminants, RVF infection causes abortion storms in pregnant females and acute deaths in newborn young. Although RVF virus (RVFV) causes an influenza-like syndrome in most human cases, a minority of these cases lead to severe forms of disease such as haemorrhagic fever, encephalitis or hepatitis. As well as its direct effects on animal and human health, RVF has important economic consequences at both the local and national levels. The most direct impacts of RVF on the pastoralist community are the loss of income, and potential food insecurity resulting from this lost income and from ruminant mortality/morbidity (Peyre *et al.*, 2014). This impact can be reduced when control measures such as vaccination, insecticide spraying and stakeholder communication are quickly implemented. The delay between case detection and the implementation of control measures depends on factors that include the efficiency of surveillance networks and the rapid reaction of animal and human health authorities.

First recognized in 1931 (Gerdes, 2004), RVF disease is endemic in sub-Saharan Africa, and was thought to be confined to the African continent, including Madagascar, until it spread to the Arabian Peninsula in 2000 (Ahmad, 2000). Recent outbreaks were recorded in the Horn of Africa, first in Kenya (CDC, 2007), Somalia and the United Republic of Tanzania (WHO, 2007) in 2006–2007; then in the Sudan (Adam, Karsany and Adam, 2010) and Madagascar in 2008 (Andriamandimby *et al.,* 2010). Outbreaks occurred in South Africa in 2008, 2009, 2010 and 2011 (Métras *et al.,* 2013), and in Mauritania in 2010 (El Mamy *et al.,* 2011; OIE, 2009); the last large outbreak occurred in 2012–2013 in Senegal (Sow *et al.,* 2014; Chevalier *et al.,* 2005; ProMED, 2013).

As a result of intensification of the international trade in live animals, nomadic habits, and the potential but unevaluated impacts of climate change on the distribution, abundance and competence of vectors, the disease now threatens North and East African countries that share borders with infected countries, and European countries where potential vectors are present (Chevalier *et al.,* 2010; Moutailler *et al.,* 2008). Given the lack of knowledge about factors triggering emergence in infected areas, and the unpredictability of outbreaks – with the exception of Kenya, where a link was clearly demonstrated between extreme rainfall events and outbreak occurrence (Linthicum *et al.,* 1999) – there is need to develop pragmatic approaches to provide risk maps in a context where data are scarce and other significant knowledge gaps exist.

Spatial multi-criteria evaluation (MCE) and multi-criteria decision analysis (MCDA) are relatively rapid and pragmatic methods for mapping disease risk in the absence of large epidemiological data sets. Geographic Information System (GIS)-based MCE processes transform and combine geographical data and value judgements – derived from expert knowledge and the literature including subjective and qualitative information, and uncertainties

©FAO/Giulio Napolitano

Cattle grazing in Ethiopia

associated with the key variables and/or epidemiological process involved – to obtain valuable information for guiding decision-making (Malczewski, 2006). A major strength of spatial MCDA is its ability to incorporate the perspectives of multiple stakeholders (resource allocation priorities, considerations related to individual and societal costs, perceived risks, strategic and policy objectives, etc.) in addition to the geographical distribution and determinants of disease risk (Hongoh *et al.,* 2011). General MCE steps include (Hongoh *et al.,* 2011): i) definition of the problem and identification of experts; ii) identification of criteria (in this case, risk factors for the spread and amplification of the disease); iii) weighting of criteria; iv) decision analysis; v) sensitivity analysis; and vi) validation.

This methodology was applied to identify likely areas of RVFV transmission in two different epidemiological contexts: i) following a hypothetical virus introduction into a European RVF-free country – Italy (Tran *et al.,* 2013); and ii) in two exposed East African countries – Uganda and Ethiopia. The African study was jointly performed by the *Animal et gestion intégréedes risques* (AGIR – Animal and Integrated Risk Management) Unit of the International Cooperation Centre of Agricultural Research for Development (CIRAD) and the Food and Agriculture Organization of the United Nations (FAO), in support of FAO's One Health project (OSRO/GLO/104/IRE) for the better management of emerging and re-emerging animal health and animal-related human health risks.

The European study produced a risk map for Italy showing the areas suitable for RVFV transmission to small ruminants and cattle by the different potential vector species, taking into account their potential capacity to transmit the virus. As no precise distribution maps were available for these vector species, the mosquito distribution was mapped based on expert knowledge and land cover as a proxy of mosquito presence. The accuracy of the mosquito distribution maps was assessed using entomological collections gathered under a West Nile surveillance programme. The entomological experts' opinions used to predict the spatial distribution of mosquito populations showed very good concordance with the findings derived from mosquito collections. The map of areas suitable for vector-borne transmission of RVFV was then combined with livestock density maps, resulting in a map of the overall risk of RVF in animal populations, taking into account possible variations in populations' sensitivity to RVFV. Data on vectors' feeding preferences were not available. In this process, data layers were combined into likelihood maps using weightings that reflect the relative importance of each layer

Table 1: Risk factors associated with transmission and spread of RVF in livestock populations identified through literature review

	Risk factor[1]	Location of observation
Individual	Species	Arabian Peninsula, Horn of Africa, Mauritania, West Africa
	Age	Senegal
Production system	Large herds, high ruminant densities*	Kenya, Yemen
	Introduction of animals purchased at market*	Madagascar
	Presence of wild ruminants and distance to conservation areas*	Kenya, South Africa, Zimbabwe
Markets/trade	Ruminant trade*	Madagascar, Saudi Arabia, Yemen
	Animal movements between neighbouring countries	Madagascar, Saudi Arabia, Yemen
	Visits to live animal markets*	Madagascar
	Festival periods*	Yemen
	Traditional and commercial practices	Madagascar
Vector populations	*Aedes, Culex, Mansonia* and *Anopheles* genera*	Egypt, Kenya, Madagascar, Saudi Arabia, Senegal, South Africa, the Sudan, United Republic of Tanzania, Yemen
Climate	Season*	Kenya, Madagascar, Senegal, South Africa, Yemen
Surveillance	Quarantine Existing prediction models and surveillance systems efficiency/sensitivity	Kenya, Madagascar, Senegal, Yemen

[1] Risk factors included in this study – those for which spatial data or proxies were available – are indicated by an asterisk.
Source: Tran *et al.,* 2014.

within a GIS-based MCE approach. Finally, the robustness of the whole process was evaluated through sensitivity analysis (Tran *et al.,* 2013).

For the study undertaken in Ethiopia and Uganda, very little information was available. There have been two reported isolations of RVFV from mosquitoes in Uganda: in 1948 from wild-caught *Eretmapodites* mosquito in Bwamba County (Smithburn, Haddow and Gillett, 1948); and in 1988 in Entebbe County (Battles and Dalrymple, 1988). A recent serological survey conducted among 30 goat farms in four districts in Uganda revealed that RVFV could have been endemic in goats, with seroprevalence rates ranging from 0 to 55 percent (Magona *et al.,* 2013). RVF occurrence has never been reported in Ethiopia, but the country shares boundaries with infected countries: Kenya (Hightower *et al.,* 2012), Somalia (Soumare *et al.,* 2007), and the Sudan (Aradaib *et al.,* 2013). Its geographical location and its large-scale commercial ruminant trade and pastoralist movements put Ethiopia at risk of RVF occurrence. The MCE methodology described for the Italy study was applied. A list of risk factors associated with transmission and spread of RVF in livestock populations was compiled from a literature review (Table 1). A preliminary map of suitable areas for amplification of RVF in Ethiopia, Kenya, Uganda and the United Republic of Tanzania, overlaid with the locations of reported 2006 RVF outbreaks, was built. The consistency of the risk maps was assessed mathematically against field data, with acceptable results.

Amplification and spread of RVF are multifactorial processes: environmental (biotic and abiotic), economic, social or cultural factors may have an impact. GIS-based MCE allows the aggregation of available knowledge of potential RVF vector and host species, making it possible to identify key parameters with a significant impact on the resulting risk maps, and the main knowledge gaps. This methodology also provides users with a straightforward and easy means of updating the maps to include more precise geographic data and new risk factors, modifying the weights of each factor, and comparing scenarios of transmission.

An important consideration for the methodology is that the quality of the maps depends on the quality of the data on risk factors (timeliness, spatial resolution, accuracy, etc.), the validity of expert opinions and the available knowledge of the epidemiological processes involved, and the

©FAO/Simon Maina

A flock of sheep drinking water

assumptions underlying these processes. For instance, in identifying suitable areas for RVF transmission in Italy and Ethiopia/Uganda, it was assumed that the virus was transmitted exclusively by vectors. However, recent field, serological and virological evidence suggests that transmission can occur in the absence of significant populations of vectors (Nicolas *et al.,* 2014). In addition, the susceptibility of different ruminant breeds and the competency of most of the mosquitoes considered, in either Italy or East Africa, are unknown and have yet to be evaluated through laboratory experiments. The choice and uses of the different proxies for vector presence have also to be clearly explained to end users. These considerations must be taken into account when interpreting the risk maps.

These studies demonstrate the potential of GIS-based MCE methods to synthesize expert and scientific knowledge in contexts of data scarcity and to map, with acceptable accuracy, the spatial heterogeneity of the risk of RVF amplification and spread in European and/or African countries. The outcomes are encouraging and provide evidence that the method is effective for mapping disease risk at the regional scale. 360

REFERENCES

Adam, A.A., Karsany, M.S. & Adam, I. 2010. Manifestations of severe Rift Valley fever in Sudan. *Int. J. Infect. Dis.,* 14(2): e179–180.

Ahmad, K. 2000. More deaths from Rift Valley fever in Saudi Arabia and Yemen. *Lancet,* 356(9239): 1422.

Andriamandimby, S.F., Randrianarivo-Solofoniaina, A.E., Jeanmaire, E.M., Ravololomanana, L., Razafimanantsoa, L.T., Rakotojoelinandrasana, T., Razainirina, J., Hoffmann, J., Ravalohery, J.-P., Rafisandratantsoa, J.-T., Rollin, P.E. & Reynes, J.-M. 2010. Rift Valley fever during rainy seasons, Madagascar, 2008 and 2009. *Emerg. Infect. Dis.,* 16(6): 963–970.

Anonymous. 1978. Rift Valley Fever Symposium, Cairo, Egypt (April 1978). *J. Egypt Public Health Assoc.,* 53(3–4): 123–280.

Aradaib, I.E., Erickson, B.R., Elageb, R.M., Khristova, M.L., Carroll, S.A., Elkhidir, I.M., Karsany, M.E., Karrar, A.E., Elbashir, M.I. & Nichol, S.T. 2013. Rift Valley fever, Sudan, 2007 and 2010. *Emerg. Infect. Dis.,* 19: 246–253.

Battles, J.K. & Dalrymple, J.M. 1988. Genetic variation among geographic isolates of Rift Valley fever virus. *Am. J. Trop. Med. Hyg.,* 39(6): 617–631.

CDC. 2007. Rift Valley fever outbreak – Kenya, November 2006–January 2007. *MMWR Morb. Mortal. Wkly Rep.*, 56(4): 73–76.

Chevalier, V., Lancelot, R., Thiongane, Y., Sall, B., Diaité, A. & Mondet, B. 2005. Rift Valley fever in small ruminants, Senegal, 2003. *Emerg. Inf. Dis.,* 11(11): 1693–1700.

Chevalier, V., Pépin, M., Plée, L. & Lancelot, R. 2010. Rift Valley fever – a threat for Europe? *EuroSurveill.,* 15(10): 1–11.

El Mamy, A.B., Baba, M.O., Barry, Y., Isselmou, K., Dia, M.L., Hampate, B., Diallo, M.Y., El Kory, M.O.B., Diop, M., Lo, M.M., Thiongane, Y., Bengoumi, M., Puech, L., Plee, L., Claes, F., de La Rocque, S. & Doumbia, B. 2011. Unexpected Rift Valley fever outbreak, northern Mauritania. *Emerg. Infect. Dis.,* 17(10): 1894–1896.

Gerdes, G.H. 2004. Rift Valley fever. *Revue Scientifique et technique de l'Office International des Epizooties,* 23(2): 613–623.

Hightower, A., Kinkade, C., Nguku, P.M., Anyangu, A., Mutonga, D., Omolo, J., Njenga, M.K., Feikin, D.R., Schnabel, D., Ombok, M. & Breiman, R.F. 2012. Relationship of climate, geography, and geology to the incidence of Rift Valley fever in Kenya during the 2006-2007 outbreak. *Am. J. Trop. Med. Hyg.,* 86(2): 373–380.

Hongoh, V., Hoen, A.G., Aenishaenslin, C., Waaub, J.-P., Bélanger, D., Michel, P. & The Lyme-MCDA Consortium. 2011. Spatially explicit multi-criteria decision analysis for managing vector-borne diseases. *Int. J. Health Geogr.,* 10: 70.

Linthicum, K., Anyamba, A., Tucker, C.J., Kelley, P.W., Myers, M.F. & Peters, C.J. 1999. Climate and satellite indicators to forecast Rift Valley fever epidemics in Kenya. *Science,* 285(5426): 397–400.

Magona, J.W., Galiwango, T., Walubengo, J. & Mukiibi, G. 2013. Rift Valley fever in Uganda: Seroprevalence and risk factor surveillance vis-à-vis mosquito vectors, anti-RVF virus IgG and RVF virus neutralizing antibodies in goats. *Small Ruminant Research,* 114(1): 176–181.

Malczewski, J. 2006. GIS-based multicriteria decision analysis: a survey of the literature. *International Journal of Geographical Information Science,* 20(7): 703–726.

Métras, R., Baguelin, M., Edmunds, W.J., Thompson, P.N., Kemp, A., Pfeiffer, D.U., Collins, L.M. & White, R.G. 2013. Transmission potential of Rift Valley fever virus over the course of the 2010 epidemic in South Africa. *Emerg. Infect. Dis.,* 19(6): 916–924. http://dx.doi.org/10.1051/vetres/2010033

Moutailler, S., Krida, G., Schaffner, F., Vazeille, M. & Failloux, A.B. 2008. Potential vectors of Rift Valley fever virus in the Mediterranean region. *Vect. Borne Zoo. Dis.,* 8(6): 749–753.

Nicolas, G., Durand, B., Rakotoarimanana, T.T., Lacote, S., Chevalier, V. & Marianneau, P. 2014. A 3-year serological and virological cattle follow-up in Madagascar highlands suggests a non-classical transmission route of Rift Valley fever virus. *Am. J. Trop. Med. Hyg.,* 90(2): 265–266.

OIE. 2009. *Rift Valley fever in South Africa.* http://www.oie.int/fileadmin/Home/eng/Animal_Health_in_the_World/docs/pdf/Disease_cards/RIFT_VALLEY_FEVER.pdf

Pépin, M., Bouloy, M., Bird, B.H., Kemp, A. & Paweska, J.T. 2010. Rift Valley fever (Bunyaviridae:Phlebovirus): an update on pathogenesis, molecular epidemiology, vectors, diagnostics and prevention. *Vet. Res.,* 41(6): 61.

Peyre, M., Chevalier, V., Abdo-Salem, S., Velthuis, A., Antoine-Moussiaux, N., Thiry, E. & Roger, F. 2014. A systematic scoping study of the socio-economic impact of Rift Valley fever: research gaps and needs. *Zoonoses Public Health.* E-pub on 24 September 2014. http://onlinelibrary.wiley.com/doi/10.1111/zph.12153/pdf

Promed. 2013. PRO/AH/EDR> Rift Valley fever - Senegal: (DK) bovine, OIE, 2013 OIE. http://promedmail.org/direct.php?id=20140318.2341029

Smithburn, K.C., Haddow, A.J. & Gillett, J.D. 1948. Rift Valley fever. Isolation of the virus from wild mosquitoes. *Br. J. Exp. Pathol.,* 29(2): 107–121.

Soumare, B., Tempia, S., Cagnolati, V., Mohamoud, A., Van Huylenbroeck, G. & Berkvens, D. 2007. Screening for Rift Valley fever infection in northern Somalia: A GIS based survey method to overcome the lack of sampling frame. *Vet. Microbiol.,* 121(3–4): 249–256.

Sow, A., Faye, O., Diallo, D., Sadio, B., Weaver, S., Diallo, M. & Sall, A.A. 2014 Rift Valley fever in Kedougou, southeastern Senegal, 2012. *Emerg. Infect. Dis.,* 20(3): 504–506.

Tran, A., Ippoliti, C., Balenghien, T., Conte, A., Gely, M., Calistri, P., Goffredo, M., Baldet, T. & Chevalier, V. 2013. A geographical information system-based multicriteria evaluation to map areas at risk for Rift Valley fever vector-borne transmission in Italy. *Transbound. Emerg. Dis.,* 60(Suppl. s2): 14–23.

Tran, A., Trevennec, C., Gély, M., Gaidet, N. & Chevalier, V. 2014. *Mapping the Risk of Spread and Occurrence of RVF and PPR in Eastern Africa. Report for FAO's One Health initiative project (OSRO/GLO/104/IRE),* Rome, Italy, FAO.

WHO. 2007. Outbreaks of Rift Valley fever in Kenya, Somalia, and United Republic of Tanzania, December 2006–April 2007. *Wkly Epidemiol. Rec.,* 82(2): 169–178.

©FAO/Giulio Napolitano

PERSPECTIVES

Emergence of porcine epidemic diarrhoea in North America

Contributors: C. Hill,[1] E. Raizman **(FAO)**, T. Snider,[1] S. Goyal,[1] M. Torremorell[1] and A.M. Perez[1]

OVERVIEW

Porcine epidemic diarrhoea virus (PEDV) was first recognized in the United Kingdom of Great Britain and Northern Ireland in 1971. Since then, PEDV has become endemic in many European and Asian countries, where PEDV infection typically results in minor outbreak incidents with relatively low mortality. In 2010, despite vaccination programmes, a virulent strain of PEDV caused high mortality in neonatal piglets in Chinese herds, and economic losses continue to mount. The first outbreak of virulent PEDV in North American swine herds occurred in the United States of America in May 2013. As of June 2013, PEDV losses had contributed to a decline in the national market of between 2.5 and 4.2 percent. The full economic impacts of PEDV losses in United States and Chinese pork markets have not been measured, and current efforts to prevent further losses focus on prevention and control strategies.

BACKGROUND INFORMATION

Global trade of live pigs, pig embryos, semen, feed ingredients and feed is common, leading to a threat of transboundary PEDV transmission into the swine populations of naïve countries. It is worth noting that PEDV does not pose a public health risk as it does not cause disease in humans. However, PEDV can have impacts on the livelihoods of producers in affected regions because of the severe and far-reaching economic losses that the disease imposes. These losses are particularly critical for small-scale farms where a high mortality rate can be devastating to food security, especially in developing countries.

In 2010, when bouts of watery diarrhoea occurred in Chinese herds that had been vaccinated against PEDV, it appeared that a new variant of PEDV was causing high mortality in suckling piglets in several regions of China. Thailand also experienced outbreaks of virulent PEDV during this time, with close to 100 percent mortality in neonatal piglets. In May 2013, outbreaks of watery diarrhoea and high piglet mortality were noted in several North American herds, and PEDV has increased in prevalence since then.

QUICK FACTS

WHAT IS PEDV?

PEDV is an enveloped, ribonucleic acid (RNA) coronavirus. In suckling pigs, PEDV causes similar disease to transmissible gastroenteritis virus (TGEV), but the two viruses belong to separate subgroups of the coronavirus family.

HOW DO PIGS GET PEDV?

Transmission of PEDV is mainly though the faecal-oral route, but many different modes of transmission are possible through either direct or indirect contact, including through sow milk, aerosol droplets and feed. Large amounts of virus are shed in the faeces as early as two days post-infection and for up to 28 days

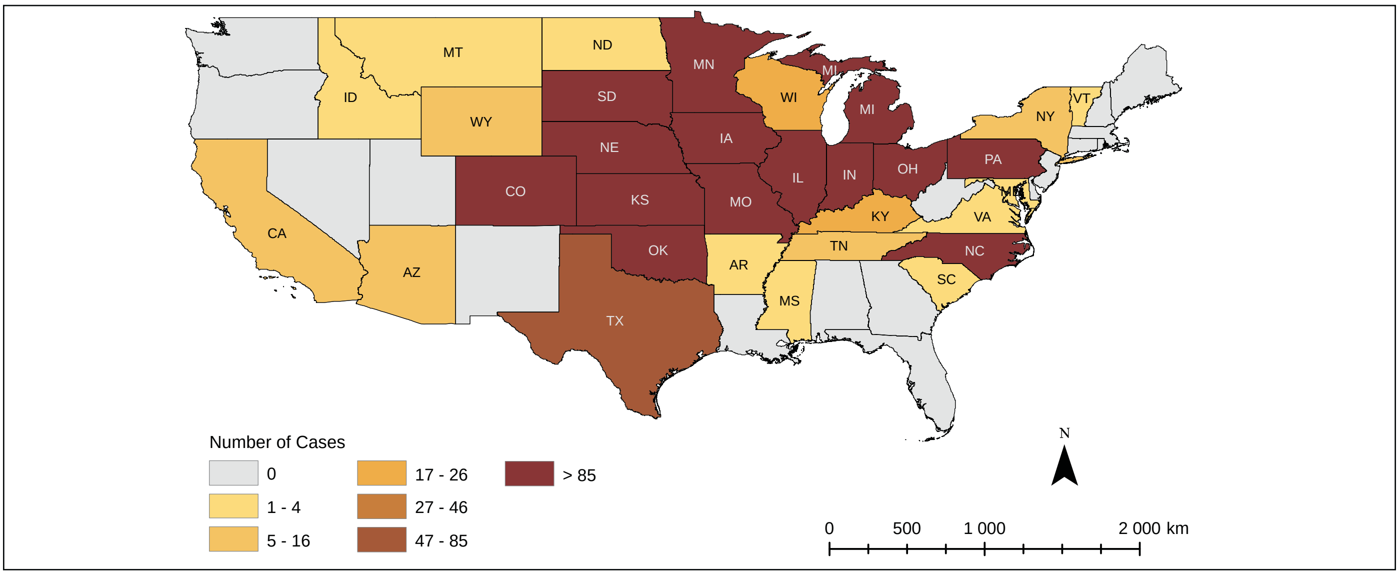


Figure 1: Number of herd cases reported for porcine epidemic diarrhoea virus, based on laboratory submissions per state in the United States of America (as of 8 March 2014)
Source: Swine Health Monitoring Project, University of Minnesota: http://www.cvm.umn.edu/sdec/prod/groups/cvm/@pub/@cvm/@sdec/documents/content/cvm_content_474670.pdf

[1]School of Veterinary Medicine, University of Minnesota

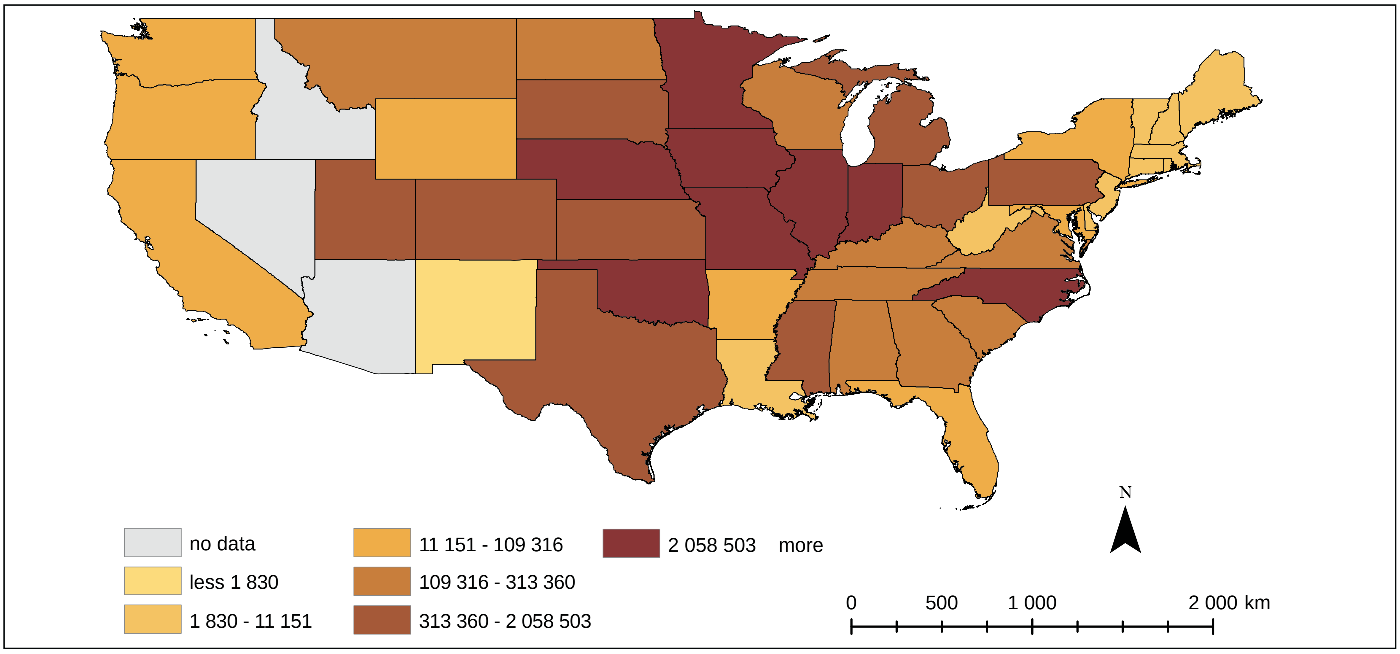


Figure 2: Pig density in the United States of America
Source: FAO GLiPHA.

post-infection. PEDV survives in fresh faeces for at least seven days at varying temperatures and humidity levels. PEDV can also be shed in nasal secretions, but the amount depends on the viral load and the presence of viraemia. Fomites also promote virus spread, as the virus is present in the environment and on contaminated equipment and clothing.

WHICH PIGS GET PEDV?

Suckling piglets under two weeks of age are most at risk where they are in close contact with litter mates and sows and rely completely on milk for nutrition. Virulent strains have pathological effects on small intestinal villi, with blunted and fused villi developing in the jejunum and ileum. Piglets present with watery diarrhoea, dehydration and vomiting approximately five to six days post-infection. Severe enteric disease eventually results in weight loss, decreased food consumption and lethal dehydration and emaciation. The survival rate of piglets increases if they live to seven days post-infection.

HOW IS PEDV DIAGNOSED IN PIGS?

A rapid, sensitive and cost-effective method of screening for PEDV during an outbreak of acute gastroenteritis is testing the faeces of infected pigs by reverse transcription polymerase chain reaction (RT-PCR). Ideal samples for submission are from live piglets in acute stages of disease. Fresh faeces from pigs with active, watery diarrhoea should also be submitted for testing. A PCR multiplex assay for PEDV and TGEV has been developed and is available through many laboratories worldwide. PCR kits for PEDV can also be obtained from corporations, but may not be readily available on a global scale.

An enzyme-linked immunosorbent assay (ELISA) has been developed to test herds for exposure to PEDV by detecting anti-PEDV antibodies, but this is not a farm-based test and is not available in all countries. In addition, although ELISA can detect exposure two to four weeks post-infection, it cannot test acute infection or exposure more than a month post-infection. Immunofluorescent antibody testing can be performed in some countries, but the laboratory must have the capacity to grow the virus *in vitro* and have trained staff to interpret the results under a fluorescent microscope.

To date, PEDV RT-PCR is the most sensitive and rapid way of diagnosing PEDV infection in a herd.

DISEASE IMPACT

To date, the virulent strains of PEDV that caused high mortality in Asia, the United States of America and Canada are not prevalent elsewhere in the world. Although Europe has experienced outbreaks of PEDV, the strain has not been highly virulent and the outbreaks have resulted in low mortality in piglets. Other pork producing countries, such as Brazil and the Russian Federation, have not reported cases of PEDV. According to Web-based reporting systems, PEDV has been diagnosed in Colombia, the Dominican Republic, Mexico and Peru.

EPIDEMIOLOGICAL OUTLOOK

In addition to faecal-oral and direct nose-nose transmission, new research has shown that PEDV can be infective in feed and in airborne particles; piglets have developed diarrhoea from these sources, and their intestinal tracts tested positive for PEDV seven days post-infection. As mentioned in the section on Quick facts, fomites can serve as routes for the spread of PEDV between farms, when veterinarians, visitors and haulers transporting hogs to market carry PEDV-infected faeces from one farm to another. The type of production system and the pig density contribute to increased risk of PEDV infections, with farrow-to-wean sites having greater risk of PEDV infection than wean-to-finish sites, and high pig density increasing PEDV risk compared with lower pig density.

Most high producing pork countries have had outbreaks of TGEV, and it seems likely that a similar pattern of PEDV outbreaks could occur in these countries if import restrictions and biosecurity are not improved. Both diseases are coronaviruses, and both cause high mortality in neonatal piglets. Raising awareness of the disease will therefore help to improve surveillance, early detection and reporting of the disease in other countries, where small-scale farms in the swine sector are the most affected because of the virus's devastating effects on farmers' livelihoods.

RECOMMENDATIONS FOR PREVENTION AND CONTROL

Improved biosecurity can also prevent outbreaks of PEDV on farms after the risk factors for PEDV introduction have been assessed. Improved biosecurity includes additional biosecurity checkpoints for visitors and personnel entering farms, and provision of off-site drop-off or pick-up points for trucks and of special entries to the farm for the drivers of these trucks. Reducing the presence of rodents, birds and raccoons on farms will reduce risk of the spread of PEDV on to and within farms. Although most

United States commercial herds are kept in closed barns, cracks in ventilation areas and broken windows or doors can contribute to the presence of rodents and birds. In pork producing countries where only semi-intensive systems are in place, rodents and wildlife have easy access to the pigs. Restricting the access of wildlife to the pigs can greatly enhance biosecurity and prevent spread of disease, including PEDV.

Early diagnosis of PEDV is the best way of decreasing piglet mortality. If PEDV is diagnosed at the first onset of acute enteric disease, exposure and elimination protocols can be enforced immediately to increase piglet survival. A vaccine for the virulent strain is being developed in China, but the best method of reducing, controlling and preventing the disease remains exposure, sanitation and biosecurity.

DISEASE ELIMINATION: FEEDBACK

Feedback is a method of exposure to and elimination of diseases that cause high mortality in piglets. Although animal rights activists have expressed concerns about this method, the motivation for its use is to mitigate the consequences of a disease. In fact, in many aspects, feedback resembles the strategy followed in the early history of vaccine development, when healthy individuals were intentionally exposed to infective products to cause disease at a stage and level at which overall health is not compromised. Exposed animals are expected to survive and develop immunity. Producers purchase enough disease-free replacement gilts to last for four to six months, and keep them separate from the current herd. The herd is then closed and monitored for acutely ill piglets. Once scours are noted in affected piglets, one or more piglets are euthanized within six hours of the onset of scours. The piglets' intestines are then macerated and washed with cold water. This material is added to the feed and fed to sows at the beginning or end of feeding periods. The infective dose must be high enough to cause clinical signs in sows, and intestines and faeces from piglets carry a higher viral load than those from adult pigs or dead piglets. Eventually, all exposed animals will exhibit clinical signs.

> " Early diagnosis of PEDV is the best way of decreasing piglet mortality "

Each sow should be monitored daily for overt clinical signs (vomiting or diarrhoea) or more subtle clinical signs (decreased food intake or increased body temperature). Affected sows are marked clearly so that healthy animals can be identified. After the first few days of initial feedback, healthy animals can be fed infected material again until clinical signs are observed. To preserve infected material, intestinal viscera from the first feedback procedure can be frozen. This process can also be performed in nursery, growing and finishing pigs to eliminate disease from the entire herd, but additional care is needed to disinfect buildings, as contamination is more widespread within these groups of pigs. After the entire herd has been exposed and clinical signs have ceased, all-in/all-out movement of animals should be enforced. Barns should be thoroughly disinfected.

Sentinel animals are procured from the same negative source as the replacement gilts and are confirmed negative for antibodies to PEDV. These pigs are isolated for 30 days before being introduced into the herd. Sentinel pigs are observed daily for signs of enteric disease. If diarrhoea occurs in sentinel animals, they are euthanized and their tissues submitted for diagnosis. Additional exposure of the herd to feedback material may be needed if sentinel animals are infected with PEDV. Blood is collected from the sentinels monthly to assess whether they have been exposed to the virus.

If no clinical signs are observed in the sentinel pigs after 30 days of introduction, and their serology is negative for PEDV antibodies, the virus is considered eliminated from the herd. Producers use feedback to mitigate disease impact in the absence of a reliable vaccine. Feedback is not recommended in herds affected with porcine reproductive and respiratory syndrome virus, as this can cause immunosuppression and older pigs may not recover from a co-infection with PEDV. Feedback is time-consuming and expensive, and the procedure is not ideal for producers who cannot enforce biosecurity or all-in/all-out systems or for low-production herds in some developing countries. 360

Full report available at: http://www.fao.org/3/a-i3967e.pdf

©FAO/Giulio Napolitano

PED affects pigs of all ages, but most severely neonatal piglets

©Les Sims

PERSPECTIVES

Assessing H7N9 risk: Combining factual field knowledge and scientific expertise

Contributors: Sophie von Dobschuetz **(FAO)**, Ludovic Plee **(FAO)**, Guillaume Belot **(FAO)**, Akiko Kamata **(FAO)**, Vincent Martin **(FAO)**, Eran Raizman **(FAO)** and Juan Lubroth **(FAO)**

Since avian influenza A(H7N9) emerged in China in early 2013, the Emergency Prevention System (EMPRES) of the Food and Agriculture Organization of the United Nations (FAO) has undertaken continuous qualitative risk assessment (QRA) of this new zoonotic threat. The outcome of QRA is a descriptive estimate of risk based on defined qualities, while quantitative risk assessment provides a numeric estimate. QRA has been used at the national level in many countries, including Australia, France, Germany, the United Kingdom of Great Britain and Northern Ireland and the United States of America, and at the international level – by the World Health Organization (WHO), the European Union and FAO – to assess specific risks where data are limited and a quick response is required, as when responding to emergencies. Such QRA is based on expert opinion.

In the context of H7N9 the QRA examines: i) the probability of pathogen introduction into an area believed to be previously unaffected; ii) the likelihood of exposure of the local animal population and of onwards spread; and iii) the magnitude of expected consequences. In the risk analysis process (Figure 1) this information is used to formulate recommendations on how to manage the risk through focused surveillance along the market chain, targeted communication and risk-based mitigation measures.

To assess the risk of H7N9 spread and the likelihood of human exposure, EMPRES applies a methodology used by other international and national risk assessment agencies, including the European Food Safety Authority (EFSA, 2007) and the French Agency for Food, Environmental and Occupational Health and Safety (AFSSA, 2008), in which groups of experts meet to draft and discuss risk assessments of proposed topics. The method is based on strict separation between scientific risk assessment and risk management, and the scientific document produced does not address risk mitigation measures or management options, which are instead decided by risk managers such as the European Commission.

This expert opinion-based qualitative methodology was adapted to fit FAO's risk management purposes of facilitating better communication on the risk factors identified in the assessment and presenting possible risk management options for limiting H7N9 spread in poultry populations to minimize the potential exposure of different human risk groups.

“To assess the risk of H7N9 spread and the likelihood of human exposure, EMPRES applies a methodology used by other international and national risk assessment agencies”

Five main risk questions are assessed (Figure 2):

Question 1: What is the likelihood of the influenza A(H7N9) virus spreading from infected premises to uninfected premises within affected areas of China?

Question 2: What is the likelihood of the influenza A(H7N9) virus spreading from a known affected area to “a moderate to high-risk” area?

Question 3: What is the likelihood of the influenza A(H7N9) virus spreading from a known affected area to a “low-risk” area?

Question 4: What is the likelihood of a human becoming exposed to the influenza A(H7N9) virus spreading from an infected bird within known affected areas of China during the specific time?

Question 5: What is the likelihood of the influenza A(H7N9) virus spreading from a known affected area to a “moderate to high-risk” area through migratory movements of wild birds?

Infected premises are defined as any premises containing infected live poultry: live bird markets, transportation trucks, poultry farms, etc.

Areas are epidemiologically classified as infected or uninfected according to the following criteria (FAO, 2013b):

- *Infected areas:* At least one positive case of avian influenza A(H7N9) has been detected by virological tests on birds (domestic, feral or wild), humans (other than humans affected by isolated imported cases) or other animals. The boundaries of these areas should be determined by epidemiological considerations, but given the limited knowledge currently available may have to be based on administrative boundaries (e.g. districts, provinces).

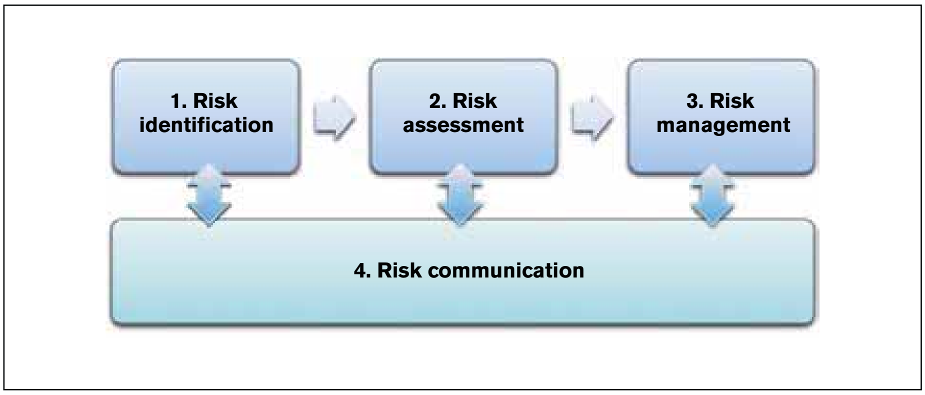


Figure 1: The risk analysis process
Source: Adapted from Covello and Merkhofer, 1993

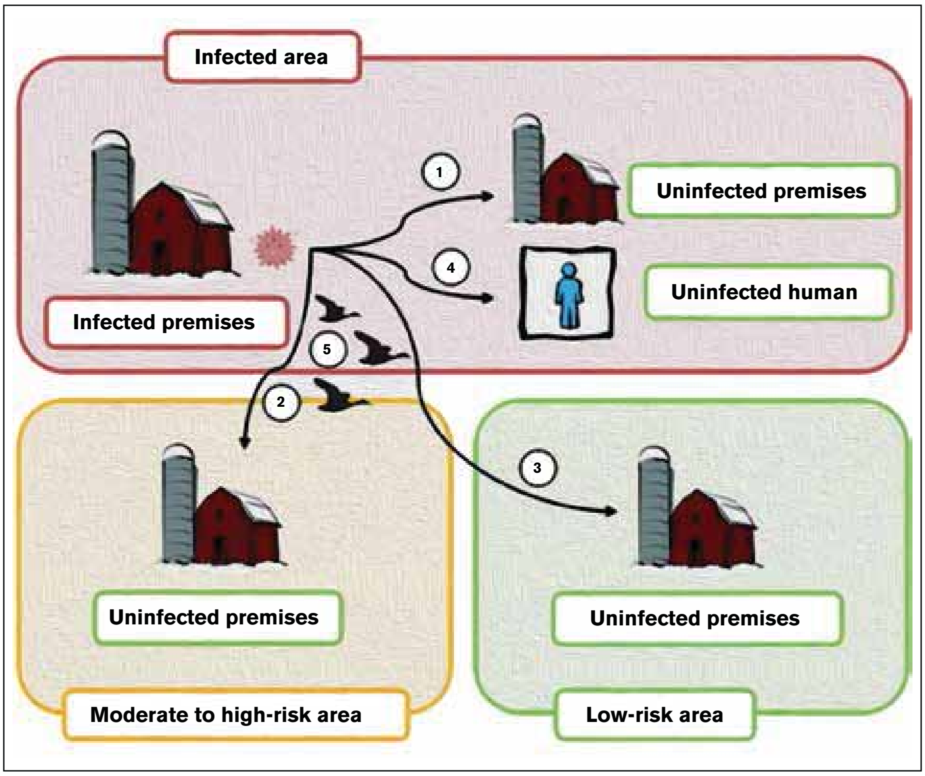


Figure 2: Main questions addressed by the H7N9 qualitative risk assessment
Source: FAO, 2014b.

- *Uninfected areas:* There is no evidence of avian influenza A(H7N9) virus circulating in birds (domestic, feral or wild), humans or other animals. These areas or countries can be differentiated into high-, moderate- and low-risk categories according to the likelihood of virus incursion. This risk classification is based on geographic proximity to infected countries/areas, known patterns of legal and informal/illegal cross-border trade in live domestic birds and bird products, and the migration patterns of wild bird species known to be the main natural reservoir of avian influenza viruses (waterfowl, shorebirds):
  - High-risk areas share a land border or have existing or historical, legal or illegal trade links in live birds or bird products with at least one infected area or country.
  - Moderate-risk areas are uninfected areas that: i) import live birds or bird products from areas that import live birds or bird products from at least one infected area; and/or ii) are connected to an infected area through the migration routes and stopover sites (depending on the season) of wild bird species known to be the main natural reservoir of low pathogenic avian influenza viruses. The cross-border trade of live birds and bird products may include historical or existing, legal or illegal trading activities.
  - Low-risk areas are uninfected areas that are not classified as high- or moderate-risk.

In FAO's risk assessment process (Figure 3), an initial draft was prepared by the H7N9 Working Group at Headquarters, which coordinates FAO's response to the H7N9 emergency through its offices in China and Southeast Asia. The draft was based on a detailed review of available information, and incorporated current knowledge on the epidemiology and behaviour of the virus in China along with prevailing conditions in the poultry sector and risk management measures implemented in Asia to date. In a second step, the preliminary assessment was subject to a multidisciplinary review by experts in FAO's Animal Health Service and other units such as the Crisis Management Centre – Animal Health (CMC-AH), Veterinary Public Health and EMPRES Food Safety. Technical contributions covered areas of animal health and production, epidemiology, virology, wildlife, marketing and trade, biosecurity, food safety, socio-economics, livestock policy, legislation, livelihoods and communication.

As a third step, regional and national FAO offices and affiliated experts reviewed the information gathered and the analysis and synthesis applied. Intensive exchanges with officers in the field improved understanding of local realities, leading to a more effective assessment of risks.

Finally, EFSA, the United Kingdom Department for Environment, Food and Rural Affairs (DEFRA) and the Royal Veterinary College (RVC) in London provided quality control as reference institutions and key partners in FAO's risk assessment activities.

RESULTS TO DATE

Three qualitative H7N9 risk assessment documents have been produced to date. The first of these evaluated potential threats posed by the novel avian influenza A(H7N9) and investigated risk pathways for onwards spread (FAO, 2013a). This initial assessment was updated twice in early 2014 (FAO, 2014c; 2014d), taking into account the latest epidemiological knowledge and specific events thought to have an impact on the assessed risk, such as the Chinese New Year festivities on 31 January 2014 and the expected decrease in influenza activity over the summer. The context of the assessment, including current knowledge of H7N9, is

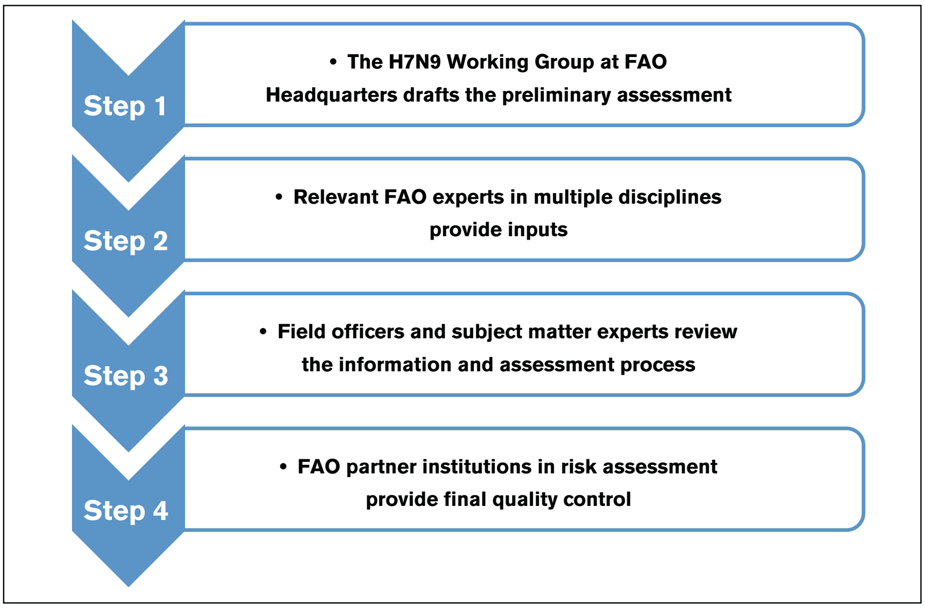


Figure 3: H7N9 qualitative risk assessment process at FAO

described in an annex, and particular attention was paid to ensuring that any information used in the assessment was referenced. Lists of risk mitigation measures, both to prevent spread of the virus in poultry and to minimize human exposure, were also included and reviewed with each new assessment.

To build national and regional capacities in preparedness and risk management and to ensure that assessment starts early on in the emergence of the virus, FAO launched four emergency Technical Cooperation Programme (TCP) projects – for Southeast Asia, South Asia, Africa and the global level – in addition to implementing a project funded by the United States Agency for International Development to support high-risk countries in Asia. FAO's goal is to assist countries in their efforts to reduce the risk of H7N9 introduction by scaling up surveillance efforts and increasing capacities for early detection and emergency preparedness. To support these activities and provide sound guidance to member countries, H7N9-specific recommendations were prepared, focusing on implementing risk-based surveillance (FAO, 2013b; 2013d), targeting and strengthening mitigation measures along the poultry value chain (FAO, 2013c), reinforcing biosecurity on premises involved in live poultry trade (FAO, 2014a), and emphasizing the importance of appropriate, targeted communication and advocacy for good production practices (FAO, 2014b).

CONCLUSIONS

QRA is a tool for identifying and prioritizing risk areas, thereby providing guidance to national authorities on where best to allocate funding, how to plan surveillance more effectively and how to adapt management policies to optimize risk mitigation measures. Such guidance is of particular importance in the context of H7N9, which is a recently emerging zoonotic avian influenza virus that does not produce clinical signs in poultry and is therefore difficult to detect. Better-targeted surveillance can help bridge the information gaps regarding which birds play roles as reservoir species and how the virus is sustained in bird populations, especially given the very low detection rate of current surveillance efforts in China. Risk assessments require regular updating as new information becomes available, to provide opportunities for adapting mitigation measures and communication messages to changing circumstances. This creates a mechanism for ensuring constant awareness at all levels, optimizing preparedness and contingency planning, facilitating cost-effective disease management, and ultimately reducing the impact of disease, including on human health.

During meetings and consultations in the framework of FAO's response to H7N9, countries repeatedly expressed a need for capacity building in risk assessment. QRA training was therefore provided during a workshop in Addis Ababa, Ethiopia in May 2014.* The workshop was organized under the TCP project Emergency Assistance for Surveillance of Influenza A (H7N9) Virus in Poultry and other Animal Populations in Low- to Moderate-Risk Countries in Africa (TCP/RAF/3408 E); participants included epidemiologists from 11 African countries: Cameroon, Côte d'Ivoire, the Democratic Republic of the Congo, Egypt, Ethiopia, Ghana, Kenya, Nigeria, Senegal, the United Republic of Tanzania and Zambia. Exercises in QRA were also offered during a meeting of South Asian countries – Bangladesh, Bhutan, India, Nepal and Pakistan – in Kathmandu, Nepal in July 2014. A methodology for joint H7N9 risk assessment by the animal and public health sectors is currently being devised by FAO's Regional Office for Asia and the Pacific in close collaboration with the tripartite – FAO/World Organisation for Animal Health (OIE)/WHO – Global Early Warning System for Major Animal Diseases, including Zoonoses (GLEWS) and EMPRES. Use of this joint risk assessment methodology will be institutionalized through training and regional and national H7N9 risk assessment activities in Asia.

FAO is in a strong position for pursuing QRA given its multidisciplinary structure, its direct access to high-level scientific expertise in its network of Reference Centres, collaborating institutions and subject matter experts, and the contributions of field knowledge from its country and regional offices. The opportunity to integrate results from FAO-commissioned studies such as value chain or cross-border trade mapping, cost-benefit analyses, behavioural surveys, risk factor analyses and surveillance constitutes another strong asset for FAO. There are plans to validate and refine the methodology developed for H7N9 risk assessment by routinely applying it to other EMPRES priority animal diseases.

* http://www.fao.org/ag/againfo/programmes/en/empres/news_050614b.html

ACKNOWLEDGEMENTS

The authors would like to express their gratitude to all the subject matter and field experts who are contributing to FAO's H7N9 risk assessments. Being able to integrate this vast knowledge adds inestimable value to the exercise and thus to the final product. In particular, the authors would like to thank John Edwards (FAO China), Fusheng Guo (FAO China), Jie Wang (FAO Headquarters), Astrid Tripodi (FAO Viet Nam), Scott Newman (FAO Viet Nam), Subhash Morzaria (FAO Regional Office for Asia and the Pacific [RAP]), David Castellan (FAO RAP), Les Sims (Asia Pacific Veterinary Information Services), Helen Roberts (DEFRA), Dirk Pfeiffer (RVC) and Stefanie Sonnberg (St Jude's Children's Hospital). 360

For the latest risk assessment see: http://www.fao.org/3/a-i3813e.pdf

REFERENCES

AFSSA. 2008. *Rapport sur une méthode qualitative d'estimation du risque en santé animale. Rapport du comité d'experts spécialisé Santé animale de l'AFSSA*. Maison-Alfort, France, *Agence française de sécurité sanitaire des aliments* (AFSSA – French Food Safety Agency). 47 pp.

Covello, V.T. & Merkhofer, M.W. 1993. *Risk assessment methods: Approaches for assessing health and environmental risks*. New York, USA, Springer Science and Business Media.

EFSA. 2007. Opinion of the Scientific Panel on Animal Health and Welfare (AHAW) on a self-mandate on the Framework for EFSA AHAW Risk Assessments. *EFSA Journal,* 550: 1–46.

FAO. 2013a. *Emergency risk assessment summary*. Addressing avian influenza A (H7N9). Rome, Italy.

FAO. 2013b. *Guidelines for emergency risk-based surveillance*. Addressing avian influenza A(H7N9). Rome, Italy.

FAO. 2013c. *Risk management along the food chain*. Addressing avian influenza A(H7N9). Rome, Italy.

FAO. 2013 d. *Surveillance guidelines for uninfected countries in Southeast Asia and South Asia*. Addressing avian influenza A(H7N9). Rome, Italy.

FAO. 2014a. *Biosecurity guide for live poultry markets*. Addressing avian influenza A(H7N9). Rome, Italy.

FAO. 2014b. *Guidelines for risk communication*. Addressing avian influenza A(H7N9). Rome, Italy.

FAO. 2014c. *Qualitative risk assessment,* Update No. 1. Addressing avian influenza A(H7N9). Rome, Italy.

FAO. 2014d. *Qualitative risk assessment,* Update No. 2. Addressing avian influenza A(H7N9). Rome, Italy.

ADVANCES

LinkTADs: main achievements to date

Contributor: Daniel Beltrán-Alcrudo **(FAO)**

Launched in November 2013, Linking Epidemiology and Laboratory Research on Transboundary Animal Diseases (TADs) in the EU and China (LinkTADs) is a €1-million initiative funded by the European Union's (EU's) Seventh Framework Programme. It coordinates European and Chinese research on animal disease prevention and control. With five European and five Chinese partners (Table 1), LinkTADs engages major scientific players in the field of animal health. The Food and Agriculture Organization of the United Nations (FAO) is the initiative's coordinator.

China's rapid economic growth, coupled with its rising population and urbanization, has led to a sharp increase in the demand for animal products. Today, China is the world's largest livestock producer and consumer. To meet such demand, livestock production has changed considerably (e.g. to more intensive farming) and trade of animals and animal products has grown dramatically, with a potential for new pathogens to emerge and spread, including to humans and across international borders. Effective prevention, management and elimination of such transboundary threats are crucial to protecting national and international food supplies, local livelihoods and human health.

To contribute to resolving the challenges faced by livestock health, LinkTADs will coordinate the development and improvement of new epidemiology and laboratory tools by linking researchers in China and Europe. It will facilitate collaboration in research among participants and ease barriers related to regulations, policies, politics and language. LinkTADs aims to: i) coordinate research across borders; ii) help find common research goals; iii) guide partners through the process; and iv) create sustainable and simple mechanisms for continued collaboration.

Under the LinkTADs umbrella, scientists from the EU and China will benefit from each other's knowledge, skills and equipment, optimizing the use of research resources and – most important – providing access to a wider pool of funding programmes. By 2016, LinkTADs aims to have established a platform that allows European and Chinese partners to coordinate future research in animal health and address universal concerns regarding TADs.

A 36-month work plan has been designed based on eight closely interrelated work packages (WPs) (Table 2). The participation of different partners in most WPs, and the horizontal cross-cutting nature of some will ensure strong interaction and coordination among partners.

Table 1: LinkTADs partners

Organization name	Country
China Animal Health and Epidemiology Center (CAHEC)	China
Chinese Center for Disease Control and Prevention (CCDC), Beijing	China
Harbin Veterinary Research Institute (HVRI)	China
Huazhong Agricultural University (HZAU)	China
Shanghai Veterinary Research Institute (SHVRI)	China
Europa Media Non-profit Ltd (EM)	Hungary
Food and Agriculture Organization of the United Nations (FAO)	–
International Cooperation Centre of Agricultural Research for Development (CIRAD)	France
Royal Veterinary College (RVC)	United Kingdom
Sociedade Portuguesa de Inovação (SPI)	Portugal
Staten Veterinärmedicinska Anstalt (SVA)	Sweden

Table 2: LinkTADs work plan

WP1: Management and coordination establishes the basis for the project (the gender strategy, advisory board, consortium agreement, etc.) and ensures smooth day-to-day coordination of activities and cooperation among partners
WP2: Analysis of animal health and food security research lays the technical foundations of the project by identifying research areas where joint actions are needed and on which future project activities should focus. WP3 and WP4 build on WP2's results
WP3: Animal health science (epidemiology) focuses on veterinary epidemiology, exchanging knowledge and fostering cooperation in priority areas/diseases
WP4: Animal health science (laboratories) is similar to WP3, and focuses on diagnostic technologies for early and rapid detection of animal pathogens
WP5: Supporting policy dialogue provides the framework (fed by evidence from other WPs, especially WP3 and WP4) and supports international policy dialogue
WP6: Platform development provides information about the project, EU-China cooperation and ongoing, past and future activities, and facilitates exchange of experiences among members of the online community
WP7: Exchanges and capacity building facilitates short-term exchanges and training programmes between European and Chinese research organizations to raise awareness of cooperation opportunities, enhance existing collaboration and encourage new partnerships
WP8: Dissemination and sustainability runs parallel to the other WPs and focuses on maximizing the project's visibility

MAIN ACHIEVEMENTS SINCE THE LINKTADS LAUNCH

Under *WP2*, which deals with *analysis of animal health and food security research*, emerging animal health, food safety and food security issues in the EU and China were prioritized. Literature reviews were carried out by the Royal Veterinary College (RVC) in the EU, and the Chinese Center for Disease Control and Prevention (CCDC) in China. Priorities were identified according

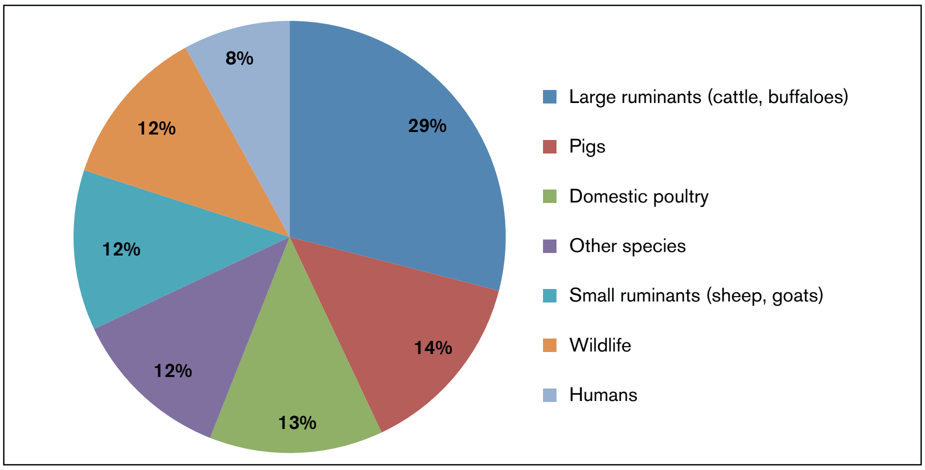


Figure 1: Main species of interest: percentage of papers relating to species

to prevalent research themes in the current scientific literature and discussions with key local stakeholders (Figure 1). Both the EU and China consider influenza, African swine fever (ASF), rabies and brucellosis to be high-priority issues, and antimicrobial resistance is a significant concern. Tuberculosis, bluetongue and foot-and-mouth disease (FMD) are of high importance in the EU, but are lower priorities in China; while porcine reproductive and respiratory syndrome (PRRS), Newcastle disease, classical swine fever (CSF), porcine epidemic diarrhoea (PED) and Aujeszkey disease (AD) are of high importance in China, but are lower priorities in the EU. In addition, although not emphasized in the literature review, peste des petits ruminants (PPR) and Japanese encephalitis (JE) were noted as emerging issues of increasing concern for China. This highlights potential opportunities for collaboration between the EU and China, which will be explored further.

Also under WP2, RVC carried out a survey to map the available resources and infrastructure in areas of animal health research and to identify specific gaps and synergies between the EU and China (Figure 2). While researchers in the EU mentioned limited access to funding as a potential barrier to research, those in China felt that lack of access to (and effective management of) databases of animal health information may be a major constraint, along with a lack of personnel trained in epidemiological methods.

Under *WPs 3 and 4 on animal health science*, the Shanghai Veterinary Research Institute (SHVRI) hosted a meeting on "Bridging Research Activities on Transboundary Animal Diseases (TADs) and Zoonoses between China and EU" in Shanghai from 14 to 16 April 2014. The workshop was a joint activity between LinkTADs and the Transmission Dynamics and Spillover of Avian Influenza under Changing Agriculture Intensification and Landscapes project funded by the United States National Institute of Allergy and Infectious Diseases. The purpose of the workshop was to: i) exchange knowledge and experiences on the epidemiology, control and prevention of TADs and zoonoses; ii) prioritize diseases of interest; and iii) discuss activities for establishing a network for the control of TADs and zoonoses.

A total of 96 participants, including scientists, experts and students from 35 institutions on three continents (Asia, Europe and America), attended the workshop; 32 delegates presented research findings.

The first day, dedicated to the epidemiology and ecology of avian influenza (AI), served as the kick-off meeting for a project on the transmission of AI in Asia, funded by the United States National Institutes of Health (NIH). Researchers from LinkTADs and NIH presented the results of their work, focusing on the linkage between epidemiology and laboratory research and providing material for discussions in an expert opinion session. Results from this session will be analysed and delivered by the end of the first year of the LinkTADs project. Interesting suggestions and recommendations emerged during the workshop, particularly regarding current knowledge gaps in AI epidemiology and how to prevent, control and manage outbreaks.

During the second and third days of the workshop, updates were presented and discussed on: i) TADs – AI, CSF, ASF, PRRS and Newcastle disease; ii) emerging and re-emerging diseases – PED, duck Tembusu virus infection and variant Aujeszkey disease; and iii) zoonoses – rabies, JE, brucellosis and tuberculosis. Participants discussed how to establish a network for controlling TADs and zoonoses, and proposed topics to be covered and potential participants.

Under *WP8 on dissemination*, EM developed the logo and visual identity for the LinkTADs project and launched the Web site, which is regularly updated with LinkTADs news and has been translated into Chinese by *Sociedade Portuguesa de Inovação* (SPI). FAO and SPI jointly developed a dissemination plan, which aims to ensure that the project creates strong awareness among its target groups and achieves its full potential impact. SPI developed Word and PowerPoint templates, a project brochure and a poster in both English and Chinese for partners to use in their communication activities. Partners also promoted the LinkTADs Web site via their own Web resources and other channels. 360

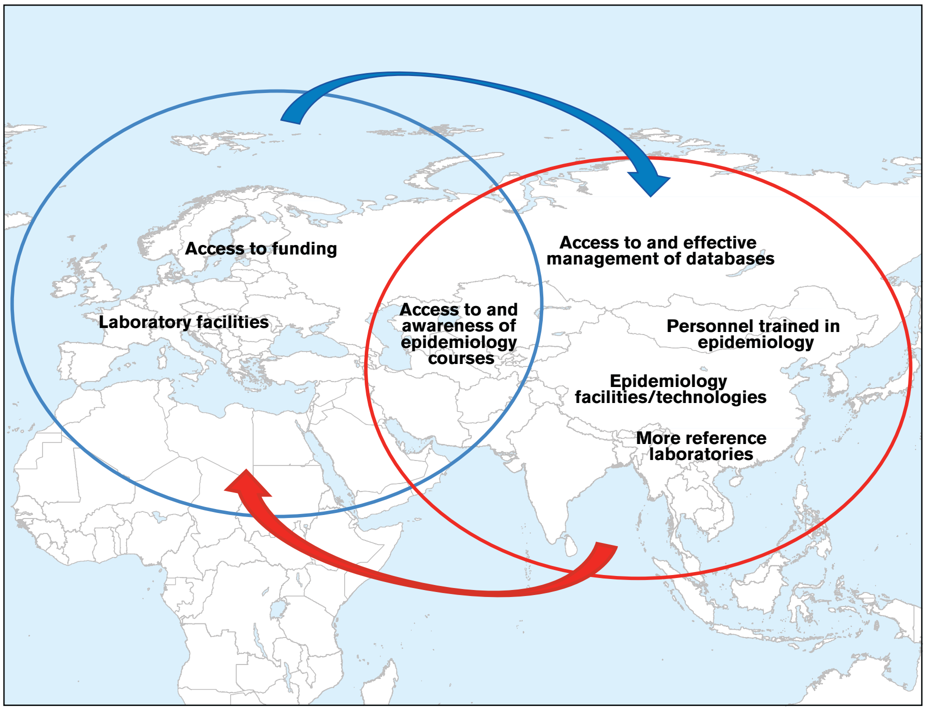


Figure 2: Gaps in animal health research resources according to perceptions of stakeholders, and opportunities for cross-collaboration


©Filip Claes

ADVANCES

Vmerge: a research consortium for better understanding of Rift Valley fever and other vector-borne diseases

Contributors: Daniel Beltrán-Alcrudo **(FAO)**, Anoek Backx **(FAO)** and Claudia Pittiglio **(FAO)**

BACKGROUND

Vector-borne diseases (VBDs) such as Rift Valley fever (RFV), bluetongue and Schmallenberg virus are an increasing threat to animal health, and their spread to previously unaffected regions of the world over recent years has raised alarm. In the case of RVF, in addition to its negative socio-economic effects on local livelihoods, food production and trade, the disease also has an important public health dimension because of its zoonotic nature.

Rift Valley fever virus (RVFV) is transmitted among livestock mainly by mosquito species and potentially by abortion products; and to humans mainly through contacts with infectious animal material, such as blood and organs during slaughter of infected animals. First reported in Kenya's Rift Valley in 1930, RVF currently exists in most of sub-Saharan Africa, particularly in eastern and southern regions. In 2000, the first outbreaks outside Africa (in Saudi Arabia and Yemen) raised concerns that RVFV might spread outside its traditional boundaries, and even enter temperate climates (e.g. Europe and North America), where both hosts and competent vectors are present.

The epidemiology of RVF is complex because of its vector-borne nature. Climate factors such as temperature, humidity and rainfall affect vector abundance, thus influencing virus transmission. Infected *Aedes* spp. mosquito eggs (resulting from transovarial transmission) can survive for several years in dry conditions, hatching when heavy rainfalls flood the soil and leading to a sudden bloom in the mosquito population that can infect the susceptible animals it feeds on, including humans. Other vectors (*Culex* spp.) can serve as amplifiers of RVF during the epidemic stages of the outbreak. This phenomenon explains how the virus causes sporadic outbreaks in endemic areas where it has been silent for long periods. When the virus is introduced (through infected animals, products or mosquitoes) into previously unaffected areas where the vector is present, epizootics and associated human epidemics can occur.

The landscape, climate and socio-economic contexts (e.g. livestock management practices) are interlinked and dynamic, but the ways in which changes in these elements influence RVF dynamics are still not fully understood. Understanding and predicting the determinants of RVF occurrence will allow the development of more cost-effective, innovative and science-based tools for disease surveillance, prevention and control in both endemic and non-endemic countries. These tools will in turn help improve the overall preparedness against this emerging threat.

Table 1: Vmerge partners

International Cooperation Centre of Agricultural Research for Development – CIRAD – France
Centre de Recerca en Sanitat Animal – CRESA – Spain
Pirbright Institute – PIR – United Kingdom
National Environment Research Council, Centre for Ecology and Hydrology – NERC-CEH – United Kingdom
Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail – ANSES – France
Friedrich-Loeffler Institut – FLI – Germany
European Agro-Environmental Health GIS Associates – Euro-AEGIS – Belgium and United Kingdom
Central Veterinary Institute of Wageningen University and Research centre – CVI-WUR –Netherlands
Food and Agriculture Organization of the United Nations – FAO – Italy and Tunisia (Subregional Office for North Africa)
Pathoquest – France
Istituto Zooprofilattico Sperimentale dell'Abruzzo e Molise Giuseppe Caporale – IZSAM – Italy
Institut Agronomique et Vétérinaire Hassan II – IAV – Morocco
Institut Sénégalais de Recherches Agricoles – ISRA – Senegal
Faculty of Veterinary Medicine of Alexandria University – FVM-AU – Egypt
Institut de Recherche Vétérinaire de Tunisie – IRVT – Tunisia
Centre National d'Elevage et de Recherches Vétérinaires – CNERV – Mauritania

DEVELOPMENT OF Vmerge

In a bid to improve the prediction and prevention emergence and spread of VBDs, under its Seventh Framework Programme (FP7), the European Commission funded the Vmerge[1] research consortium on emerging viral VBDs. Of the 16 partners in this consortium (Table 1 and Figure 1), five are based in northern Africa and Senegal, and the rest are in Europe.

Coordinated by the International Cooperation Centre of Agricultural Research for Development (CIRAD), Vmerge is structured into seven work packages (WPs):

- WP1 – Arbovirus detection, microbial ecosystems;
- WP2 – Vector ecology and competence;
- WP3 – Integrating ecology and epidemiology;
- WP4 – Surveillance control methods and strategies;
- WP5 – Data management, sampling and modelling;
- WP6 – Dissemination and field implementation;
- WP7 – Coordination.

In February 2014, the *Institut Agronomique et Vétérinaire Hassan II* (IAV) hosted the Vmerge kick-off meeting in Rabat, Morocco, where the 16 partners came together for the first time to discuss and programme the next three years of activities. The World

[1] http://www.vmerge.eu/

Organisation for Animal Health (OIE) and the European Food Safety Authority (EFSA) attended this meeting as members of the Advisory Board.

FAO AND Vmerge

For the Food and Agriculture Organization of the United Nations (FAO), the main aim of involvement in the consortium is to translate the enhanced understanding of RVF epidemiology catalysed by Vmerge into improved early warning, preparedness and surveillance. FAO-led activities are included in WPs 3, 4, 5 and 6:

- Undertaking *disease modelling and risk mapping* to improve early detection and preparedness. Innovative methods will be explored to optimize RVF prediction in Mauritania and Senegal based on environmental and climate variables (under WP3). Risk maps will be produced regularly and shared online through the FAO Web site (WP5).
- Proposing *new policy and surveillance strategies in northern Africa and the Sahel*. FAO will ensure that existing and newly generated scientific knowledge on vector ecology, RVF epidemiology and risk modelling is translated into policies, manuals and guidelines and disseminated at the country and regional levels. These tools will help national authorities to adapt their contingency plans and be better prepared and equipped against incursions of RVF (WP6).
- Providing *training and capacity building* to fill any gaps, including the skills needed for detecting, preventing and controlling VBDs (WP4).
- Mapping of past, present and future projects on RVF and vector ecology, to allow rapid access to relevant data and stakeholders while avoiding the duplication of efforts (WP6). (Further details are provided in the next section.)

> “FAO will help link research institutions to national authorities to promote the sharing of scientific results and the development of new policies”

- Developing *the RVF genetic module* as a tool to encourage molecular epidemiology. Linking gene sequences (stored in sequence databases) to the outbreaks in which they originated (locations stored in FAO's Global Animal Disease Information System – EMPRES-i) will facilitate understanding of the distribution of virus strains; whether a virus was recently introduced or already present; the possible origins of an outbreak; and the likely routes of spread (WP4).

FAO stresses the need for enhanced collaboration between research institutes and veterinary services. Because of its geographical focus, Vmerge will collaborate closely with the Mediterranean Animal Health Network (REMESA), which serves as a platform for veterinary services in northern Africa and southern Europe. The success of the project will be highly dependent on ensuring the active and early involvement of veterinary services through REMESA focal points. As joint host to the REMESA Secretariat with OIE, FAO will facilitate close coordination between Vmerge and REMESA through timely exchange of information, back-to-back Vmerge-REMESA meetings and joint planning of activities. These efforts will be crucial for the implementation of field activities and the adoption of new knowledge, strategies and tools by veterinary services. On a wider scale, FAO will help link research institutions to national authorities to promote the sharing of scientific results and the development of new policies based on Vmerge outcomes. Disseminating knowledge from Vmerge in the wider animal health community will help enhance the integration of all inputs into better prepared disease response plans and operations.

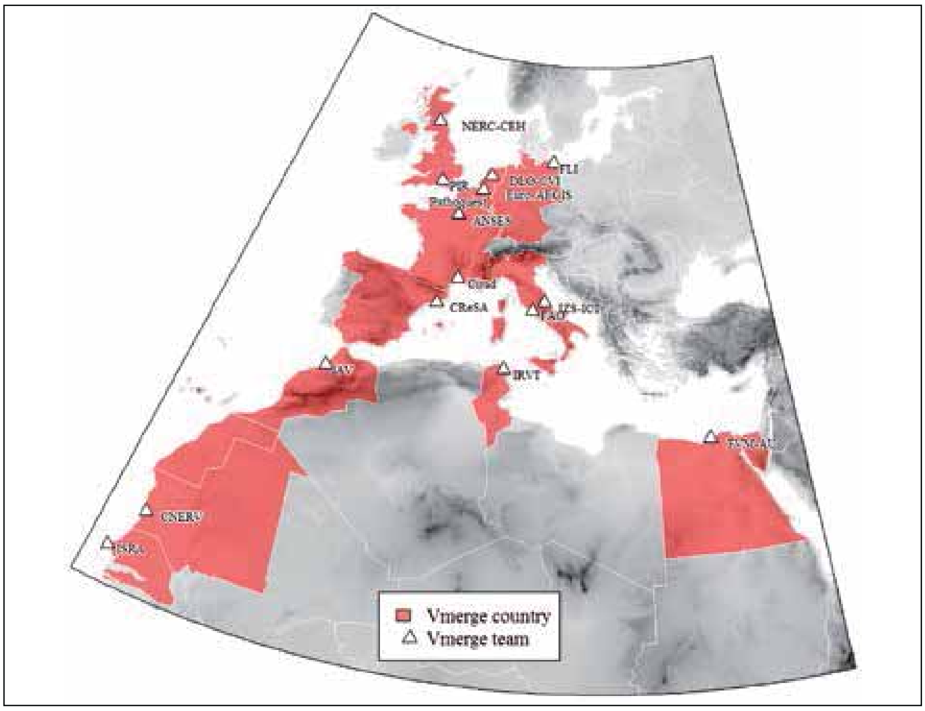


Figure 1: The Vmerge research consortium

FAO'S ACHIEVEMENTS IN THE FIRST SIX MONTHS

MAPPING AND CATEGORIZATION OF RVF PROJECTS

Many projects are studying RVFV and its vectors, focusing on early warning, surveillance, vector control, animal immunization, raising stakeholder awareness and other topics. Overlaps in topics, research methods, partners, timing and target regions are common.

In June 2014, under WP6, FAO finalized the categorization and compilation into one database of past, ongoing and future projects on RVF and involved vectors. This database will provide researchers, veterinary and public health services and policy-makers with ready information about the different research areas, partners, scopes of work, time spans and geographical coverage of projects. Open access to such information will help the planning of future projects by facilitating the identification of possible partners and knowledge gaps, while avoiding undue duplication. It will also facilitate the creation of new multidisciplinary partnerships.

Material for the database was found via thorough searches on Google, Google Scholar, Science Direct, Medline and FAO project documents. The Vmerge consortium and external RVF experts reviewed and added to the preliminary compilation. The project mapping file is presented in the form of an Excel document with projects classified by category. Accessible through both the FAO and Vmerge Web sites, it is a dynamic file that FAO intends to update regularly through sharing with the RVF community during the project and after its completion. 360

©Les Sims

ADVANCES

H7N9 surveillance in South and Southeast Asia

Contributors: Guillaume Belot **(FAO)**, Sophie Von Dobschuetz **(FAO)**, Filip Claes **(FAO)**, Akiko Kamata **(FAO)**, Subash Morzaria **(FAO)**, John Edwards **(FAO)**, Tony Williams **(FAO)**, Scott Newman **(FAO)**, Chintana Chanthavisouk **(FAO)** and Nitish Debnath **(FAO)**

CONTEXT

Avian influenza A(H7N9), a zoonotic virus, emerged in China in March 2013. As of 1 August 2014, a total of 451 human cases had been reported, of which 167 had a fatal outcome (37 percent case fatality rate), but the true human infection is poorly documented. Eighty percent of cases reported a history of direct or indirect exposure to live domestic poultry (mainly chickens) at live bird markets (LBMs). Through surveillance, the H7N9 virus was detected in live birds, the LBM environment and, to a lesser extent, chickens on farms in affected areas of China. The main host of influenza A(H7N9) appears to be domestic poultry, in which the virus seems to be avirulent; epidemiological and experimental evidence shows that infected birds shed virus without showing any clinical signs. This "silent" infection increases the likelihood of undetected virus spread over wide geographical regions, and consequently of human exposure. Therefore, passive, event-based surveillance cannot be applied for the early detection of H7N9 in poultry populations. Instead, surveillance with active sampling and virological testing for early detection needs to follow a risk-based approach targeting the areas, markets and production systems at highest risk of virus introduction.

Since the emergence of the virus, the Food and Agriculture Organization of the United Nations (FAO), with the support of the United States Agency for International Development (USAID), has played a leading role in providing technical and policy-level support to China and neighbouring countries that are considered at high risk of influenza A(H7N9) incursion. This support has focused on planning and conducting surveillance in Bangladesh, Bhutan, Cambodia, Indonesia, the Lao People's Democratic Republic, Myanmar, Nepal and Viet Nam, supporting the development of emergency preparedness and response plans as well as enhancing surveillance capacity. While prospective surveillance was designed for the early detection of H7N9 incursion, a second aim of these efforts was to assess whether incursion of the virus had already occurred and remained undetected and, if so, the extent of infection in different farm types, poultry species, other livestock (e.g. swine), wild birds or the environment. At the same time, the diagnostic capacity of animal laboratories in the region was increased to enable detection of this novel virus and timely reporting of results.

Table 1: Numbers of virological and serological samples tested retrospectively for H7N9

	Bangladesh	Bhutan	China	Indonesia	Viet Nam
Virological samples	10 560	150	10 078	380	1 234
Serological samples	10 560	-	9 910	-	-

ADVANCES

Two approaches to surveillance were applied: retrospective testing on previously collected samples; and prospective collection of samples using a targeted, risk-based surveillance approach.

RETROSPECTIVE TESTING

Retrospective testing was performed in Bangladesh, Bhutan, China, Indonesia and Viet Nam on stored virological and serological samples collected as part of FAO's H5N1 highly pathogenic avian influenza (HPAI) surveillance activities and the Emerging Pandemic Threats plus (EPT+) Program, both funded by USAID. Samples collected from poultry, wild birds and swine between January and April 2013 were tested for H7N9: a total of 6 323 duck and 4 237 swine samples from Bangladesh; 150 swabs from chickens and wild birds in Bhutan; 10 078 nasal swabs and 9 910 serum samples from swine in China; 380 chicken swabs in Indonesia; and 1 234 nasal swabs from swine in Viet Nam. All of these virological and serological samples were negative for H7N9 (Table 1).

RISK-BASED TARGETED SURVEILLANCE

Through FAO's animal influenza surveillance networks already in place, new samples were collected from May 2013 along national and cross-border value chains in sites determined to be at high risk of H7N9 incursion. Using both value chain analysis and geographical/demographic assessments, the areas at highest risk of virus introduction were determined according to five criteria: i) presence of legal or illegal live poultry trade links from infected areas; ii) presence of a physical border with an infected area; iii) proximity to a migratory bird pathway; iv) high poultry density; and v) history of H5N1 HPAI outbreaks. In a second step, targeted LBMs were selected if they: i) traded imported birds; ii) had high throughput of poultry; iii) were closely connected within trade networks; and/or iv) showed a very low level of biosecurity. Farms with regular poultry imports and locations known to have had multiple introductions of H5N1 HPAI viruses or other avian influenza viruses were also included.

Risk-based, targeted surveillance was conducted in Bangladesh, Bhutan, Cambodia, the Lao People's Democratic Republic, Indonesia, Myanmar, Nepal and Viet Nam. The surveillance framework (including frequency of sampling rounds, sampling size and target species) was adapted to the specific situation in each country. In some areas it was necessary to modify the surveillance design to adapt to changes in the poultry value chain.

In the Lao People's Democratic Republic, Myanmar and Viet Nam, after high-risk areas had been identified, priority retail LBMs and poultry gathering points were targeted for surveillance. The majority of samples were oropharyngeal swabs from chickens, or environmental swabs. Other poultry species, including ducks and quail, were also sampled, but to a far lesser extent as their role in H7N9 virus transmission seems to be limited, according to the scientific information available to date. In Bangladesh, Bhutan and Nepal on the other hand, surveillance efforts focused on the interface between domestic and wild birds,

Table 2: Numbers of virological samples collected from poultry, wild birds and the environment for H7N9 risk-based surveillance (from May 2013 to June 2014)

Viet Nam	Myanmar	Bangladesh	Nepal	Lao People's Democratic Republic	Cambodia	Indonesia	Bhutan	Total
33 480	12 844	11 333	2 204	1 822	1 800	864	780	65 127

with the objective of ascertaining whether or not the virus could circulate in and be spread by wild bird populations. Collected samples were first tested for avian influenza, with positive samples undergoing further analysis to determine subtypes. In addition to scanning for H7N9, this laboratory algorithm also allowed screening for other avian influenza viruses.

No H7N9 virus was found in any of the samples collected and tested from the eight countries from May 2013 to June 2014 (Table 2).

The surveillance capabilities of countries were further strengthened through the training of staff at all participating animal health laboratories and the procurement of reagents and other materials. Skills and knowledge regarding correct virus sampling and submission procedures and H7N9 laboratory diagnosis were enhanced, increasing the capacity for future surveillance projects. National capacity in developing emergency preparedness and response plans for H7N9 was also strengthened, with emphasis on coordinated animal and public health activities.

Almost one year after the start of H7N9 surveillance activities, representatives of the animal and public health ministries of the Lao People's Democratic Republic, Myanmar and Viet Nam came together in Yangon, Myanmar at the end of April 2014 to discuss major issues related to H7N9 surveillance and contingency planning. FAO and the World Health Organization (WHO), with the support of USAID, organized the meeting to provide an opportunity for sharing surveillance results and discussing difficulties encountered and lessons learned. Challenges discussed included adapting surveillance to ever-changing value chains, ensuring an adequate cold chain for sample transport and storage, and planning for timely laboratory testing of surveillance samples in an environment where many other endemic diseases with high economic or public health impact are common and therefore receive priority in investigation efforts. Country teams recognized that the timely sharing of surveillance data with neighbouring countries and the international community contributes to better preparedness. FAO and USAID will continue to support surveillance in the areas/countries that are at highest risk of incursion of influenza A(H7N9).

In conclusion, the risk-based approach described in this report increases the chance of early detection of influenza A(H7N9) incursion into domestic poultry populations, facilitating the efficient allocation of scarce surveillance resources. Longitudinal, risk-based surveillance of poultry ascertains the epidemiological status not only of H7N9, but also of other avian influenza viruses, such as H5N1 HPAI. In conjunction, advanced virological analysis can be applied to the field strains detected to assess mutations or reassortment events that increase the likelihood of human pathogenicity. The methods described for this field activity can be utilized to maximize the chances of detecting incursions or circulation of any poultry viruses of public health concern.

To address the H7N9 emergency, FAO Headquarters, in collaboration with the regional Emergency Centre for Transboundary Disease Operations (ECTAD) office for Asia and the Pacific Region (RAP), country teams and international experts, has developed and published a set of guidance documents. *Guidelines for emergency risk-based surveillance*[1] aims to assist national authorities in implementing an efficient surveillance strategy for the rapid detection of virus incursion or spread. This risk-based strategy relies on the identification of high-risk poultry trade nodes and probable points of virus entry. *Surveillance guidelines for uninfected countries in Southeast Asia and South Asia*[2] was published in November 2013 and describes a short-term, risk-based surveillance strategy based on current understanding of H7N9 epidemiology, identified modes of spread and the predicted risk of infection for non-infected areas or countries. A third document, *Laboratory protocols and algorithms,*[3] offers guidance on experimental protocols shown to be highly sensitive in detecting H7N9 viruses in surveillance samples. It includes an overview of primers and probes to test for H7 and N9, and validated reverse transcription polymerase chain reaction (RT-PCR) protocols for the testing of collected samples.

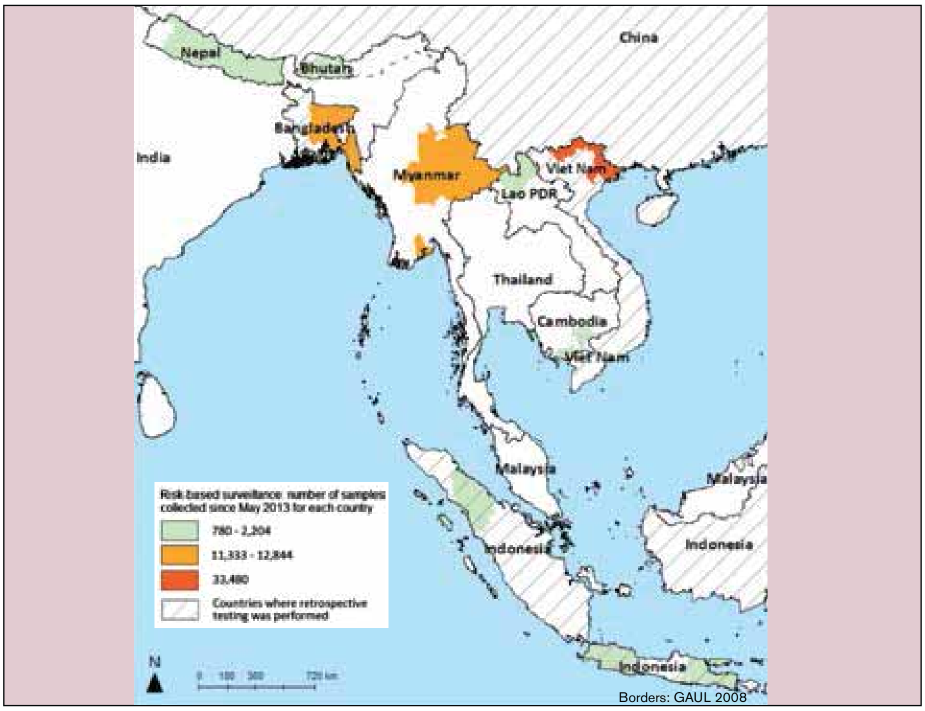


Figure 1: South East Asian countries where retrospective testing and/or risk-based surveillance were conducted

ACKNOWLEDGEMENTS

The authors would like to thank the Ministries of Agriculture of Bangladesh, Bhutan, Cambodia, China, Indonesia, the Lao People's Democratic Republic, Nepal and Viet Nam. They also thank all the experts who contributed to the development and implementation of H7N9 surveillance activities, particularly Guo Fusheng and Li Yin (FAO China), Ken Inui, Leo Loth and Astrid Tripodi (FAO Viet Nam), Wantanee Kalpravidh (FAO RAP), Mat Yamage (FAO Bangladesh), Mohinder Oberoi (FAO Nepal), Vincent Martin (FAO Senegal), Guillaume Fournie (Royal Veterinary College, London), and Carlène Trevennec and Eran Raizman (FAO Emergency Prevention System). 360

[1] http://www.fao.org/docrep/019/i3608e/i3608e.pdf
[2] http://www.fao.org/docrep/019/i3601e/i3601e.pdf
[3] http://www.fao.org/docrep/019/i3596e/i3596e.pdf

©Eran Raizman

FAO IN ACTION

FAO mission to evaluate Mongolia's preparedness for a potential incursion of peste des petits ruminants

Contributor: Eran Raizman **(FAO)**

Mongolia is a vast, sparsely populated and landlocked country of about 2.9 million people bordered on the east, south and west by China and on the north by the Russian Federation. Livestock are important to its economy, with a total of about 39 million sheep and goats contributing about 85 percent of agriculture sector production. There is therefore a significant government commitment to protecting this important economic resource.

In late February 2014, the Government of Mongolia requested assistance from the Food and Agriculture Organization of the United Nations (FAO) in assessing the country's preparedness for a potential incursion of peste des petits ruminants (PPR). In response to this official request, FAO's Crisis Management Centre – Animal Health (CMC-AH) sent a rapid deployment team of four experts to Ulaanbaatar on 21 April 2014. Although the disease has never been diagnosed in Mongolia, the recent large number of PPR outbreaks (approximately 150) reported in China since December 2013 has led to serious concerns about the risk of an incursion along the border between the two countries.

The mission's objectives were to:

- carry out a rapid qualitative risk assessment of PPR entry into Mongolia, and identify risk factors for the spread of the disease in the country;
- provide advice on PPR control, especially on surveillance, monitoring and vaccination measures;
- provide recommendations to facilitate recognition and reporting of the disease;
- assess the short- and medium-term training needs of national veterinary services to ensure an effective prevention and control programme for PPR.

©Eran Raizman

Small ruminants and herder in Mongolia. The long pole, or uurga, is used to catch horses

During the visit, the team met the Mongolian Chief Veterinary Officer (CVO), other Veterinary and Animal Breeding Agency veterinarians, and representatives of the Border Inspection Department and the General Agency for Specialized Inspection; visited the State Central Veterinary Laboratory; and met representatives of the Swiss Agency for Development and Cooperation (SDC), which is supporting development of the animal health sector in Mongolia. During a field trip to Dornogobi Province in the southeastern part of the country bordering China, the team visited Dornogobi Provincial Veterinary Laboratory in Sainshand and met local officers in several *sums* (districts). The team also visited several herders, enabling team members to collect valuable information on disease management and to experience the Mongolian people's outstanding traditional hospitability. On the mission's last day in Dornogovi, the team visited Zamiin Uud, the largest border crossing between Mongolia and China, and met government officials including veterinarians from the Border Inspection Agency.

As an outcome of this mission and in accordance with the mission objectives the team recommended:

- developing a risk based response policy to be documented in a contingency plan for PPR;
- reviewing health requirements for imports of small ruminants;
- establishing syndromic surveillance for small ruminant respiratory and enteric diseases;
- implementing PPR training and awareness-raising activities;
- enhancing laboratory capacity for PPR diagnosis and streamlined sample submission;
- ensuring timely access to PPR vaccine in the event of an outbreak;
- participating in a regional approach for enhancing small ruminant health.

In response to the mission recommendations, in July 2014, Dr Bolortuya Purevsuren, CVO of Mongolia, stated that the *Department of Veterinary* and *Animal Breeding* (DVAB) was currently developing a surveillance strategy that will include syndromic surveillance in small ruminants. PPR awareness materials for veterinarians were also being developed and put on to DVAB's Web site. DVAB had agreed to train laboratory staff on PPR diagnosis in collaboration with the SDC animal health project in Mongolia and the International Atomic Energy Agency. The Animal Health Law under revision was expected to be submitted to the Mongolian Parliament in October 2014.

Dr Bolortuya suggested that further collaboration with FAO will focus on:

- technical assistance on communication tools and implementation to enable field veterinarians, herders and beneficiaries to play the main role in controlling and preventing PPR and foot-and-mouth disease;
- establishing a short-term epidemiology training programme for field veterinarians;
- developing a contingency plan for PPR. 360

©Carolyn Benigno

FAO IN ACTION

Mission to the Democratic People's Republic of Korea to investigate an outbreak of foot-and-mouth disease

Contributors: Eran Raizman **(FAO)**, Carolyn Benigno **(FAO)** and Peter De Leeuw **(independent consultant)**

The country last reported outbreaks of foot-and-mouth disease (FMD) to the Food and Agriculture Organization of the United Nations (FAO) and the World Organisation for Animal Health (OIE) in 2007 and 2011. The Asia 1 strain outbreak in 2007 was the first FMD outbreak reported since 1960. It occurred on a State farm and was purportedly related to the importation of calves from China. No secondary outbreaks were reported. The FAO mission in 2007 provided advice for actions in the field and developed a Technical Cooperation Programme (TCP) project. A follow-up project ran from 2008 to 2009, focusing mainly on capacity building at the diagnostic laboratory, the development of a contingency plan, and some vaccine procurement.

The type O outbreak in 2011 affected more than 100 farms, mainly with cattle but also with pigs. The authorities of the Democratic People's Republic of Korea stated that it had been eradicated thanks to the assistance of FAO in providing advice on immediate measures, diagnostic kits, disinfection materials and portable equipment, vaccines, needles and syringes, and training related to the vaccination campaign and vaccination techniques.

At the request of the Chief Veterinary Officer (CVO) of the Democratic People's Republic of Korea, the Emergency Prevention System (EMPRES) of FAO fielded a mission to assist the country in diagnosing and controlling outbreaks of FMD that were reported from 17 pig farms in the Pyongyang area in February 2014. The mission took place from 14 to 21 March 2014.

The objectives of the mission in March 2014 were to: i) assess the current FMD outbreak, review the control measures taken by national authorities and provide advice for improving these measures; ii) assess current surveillance strategies for the early detection of and response to diseases such as FMD; iii) review diagnostic procedures and provide advice and assistance to improve laboratory procedures; iv) examine factors that influence the effectiveness of FMD vaccination in the country and suggest means of improving vaccination; v) advise on preparedness, response and contingency plans, including awareness, early detection and appropriate risk reduction measures that could support control of the disease; and iv) assist the Government of the Democratic People's Republic of Korea in developing an action plan to manage short- and medium-term control measures.

The mission team visited two industrial pig farms near Pyongyang and a crop production farm where draught cattle with signs of FMD were reported on 14 March. Visits were also made to the Central Hygienic and Anti-Epidemic Station, the Central Veterinary Station and the Agricultural Academy Veterinary Research Laboratory. The team met the CVO of the Democratic People's Republic of Korea shortly after arrival and at the end of the mission. From these visits, the mission team drew the following findings:

- Given the lack of sustainable government commitment, there was an urgent need to supply FMD quality-assured diagnostic kits and to train laboratory staff in using the kits and interpreting results.
- Training in basic and practical epidemiology (sampling design, sampling techniques and interpretation of test results) was required.
- Intensified and structured laboratory cooperation with the FAO FMD

©Carolyn Benigno

EMPRES team and local veterinarians sample an animal with clinical FMD to determine the virus strain. Knowing the exact virus strain is crucial for matching to the appropriate vaccine

©Eran Raizman

A medium-sized swine production facility with advanced biosecurity measures near Pyongyang

Reference Laboratory at Lanzhou, China would be very beneficial for laboratories in the Democratic People's Republic of Korea.

Understanding of basic biosecurity and sanitary procedures needs to be improved through proper training. The country lacks current access to veterinary textbooks, literature and instruction manuals.

PERSONAL PROTECTIVE CLOTHING IS LACKING.

During the 2011 outbreak of FMD type O, assistance was provided for a targeted vaccination campaign, including training to ensure proper delivery of the vaccine (customs clearance, adequate cold chain storage, proper handling and application) and post-vaccination monitoring. Apparently, post-vaccination monitoring was not carried out, and there was no active FMD surveillance between 2011 and 2014.

The lack of FMD quality-assured diagnostic kits is a major bottleneck for sustainable early detection of any animal disease. Knowledge of recent veterinary and technical developments was also limited, reflected by the lack of modern textbooks.

RECOMMENDATIONS

Restrict all animal movements to and from industrial pig and crop farms with FMD-infected draught cattle and across larger areas, such as within a 10-km radius of an FMD-infected epidemiological unit; these zones should be combined, as advised in 2011.

Containment measures on individual industrial pig farms should be maintained for at least two months after the last FMD clinical signs have been noted. Daily clinical inspections should focus on increased mortality in piglets on farms where partial stamping out has been practised while other pig houses on the farm remained free of FMD. On farms where the virus has spread widely and most pigs are likely to have acquired immunity, particular attention should be given to weaned pigs losing maternal immunity, and containment measures should be maintained for three to four months after the last clinical signs have been noted.

The FMD containment strategy should be backed up by an emergency vaccination campaign targeting the strategically most important animal (sub-)populations. Future vaccination campaigns should be used to vaccinate animals around the outbreak areas near Cholwen village. A larger vaccination campaign will depend on support from the international donor community.

The team noted that for FMD control, the rendering, burying or burning of carcasses of infected or suspect pigs is preferred in most countries. However, in countries where stamping out is not practised or practical because food and feed supplies are critically low, the carcasses are sometimes boiled and fed to pigs on the same farm. Whole carcasses should be boiled until they are thoroughly cooked through before they are chopped up and left to cool before being fed to pigs.

Every industrial pig farm should keep full records of all events of possible epidemiological significance, such as the pigs received or delivered, the feed and bedding received, animal treatments, and visitors. The authorities should strive to establish the use of electronic farm records that are shared in a central system.

Samples should be dispatched to an OIE or FAO Reference Centre as quickly as possible.

The virus type(s) prevailing in the area should be determined unequivocally before vaccines are purchased or imported.

Draught animals around Cholwen village should be protected with the first vaccine that becomes available.

Emergency brigades should be trained in vaccination and vaccine management.

Ways of providing laboratory kits and textbooks need to be facilitated. An emergency TCP project from FAO has been formulated and is currently in the initial stages of implementation. The project covers laboratory aspects as well as training in biosecurity and epidemiology. Structural cooperation with the FMD Reference Centre at Lanzhou, China was also recommended to be pursued and facilitated.

Post-mission results from laboratory analysis at the FAO FMD Reference Laboratory in Lanzhou, China indicate that serotype O was present in pigs, while serotype A was present in cattle. The results will inform the selection of an appropriate vaccine to apply as a preventive measure.

EMPRES is following up on implementation of the recommendations to ensure the development of sustainable government capability to respond to such outbreaks in the future. 360

©FAO/Tariq Tinazay

NEWS

Highly pathogenic avian influenza H5N8: from Asia to Europe – the highway or the flyway?

Contributors: Guillaume Belot **(FAO)**, Sophie Von Dobschuetz **(FAO)**, Filip Claes **(FAO)** and Eran Raizman **(FAO)**

The first reports of highly pathogenic avian influenza (HPAI) H5N8 virus date back to surveillance in live poultry markets in eastern China in November 2013 (Wu *et al.,* 2014). The virus has since caused more than 40 outbreaks in poultry farms in China, Japan and the Republic of Korea. In early November 2014, H5N8 HPAI was detected in Europe for the first time, with outbreaks in poultry reported in Germany (one turkey-fattening farm), the Netherlands (two breeder and one layer hen farms) and the United Kingdom of Great Britain and Northern Ireland (one breeder duck farm). Genetic analysis of the isolated viruses confirmed their close similarity to the viruses spreading in eastern Asia.

The same H5N8 virus was also detected in a number of wild waterfowl species in Asia, and in an apparently healthy common teal (*Anas crecca*) hunted in Germany to the northwest of where the poultry outbreak had been observed. These findings support the hypothesis that wild birds may have played a role in the long-distance spread of H5N8 HPAI from Asia to Europe. Experimental trials in the Republic of Korea show the virus causes only mild signs associated with a low mortality rate in wild ducks, but leads to sufficient viral shedding to infect other birds by contact. It also seems likely that the virus was introduced through means other than common poultry production channels because it was detected: i) in a short time frame; ii) in three European countries and three very different production systems; and iii) in the absence of epidemiological links between the index farms of these countries or to affected farms in Asia.

In addition, small genetic differences observed among the European viruses suggest that the outbreaks in Europe were caused by multiple introductions of slightly different viruses, likely originating from a pool of H5N8 viruses that has been established in bird populations following genetic evolution over time. Even if the evidence for wild birds' involvement in the spread of H5N8 is overwhelming, questions remain about the mechanisms and species involved. The Emergency Prevention System (EMPRES), together with scientific experts and the wildlife group of the World Organisation for Animal Health (OIE)/Food and Agriculture Organization of the United Nations (FAO) Network of Expertise on Animal Influenza (OFFLU),[1] is working on a risk assessment and surveillance guidelines for affected countries and those at risk.

The World Health Organization (WHO) assessed the current risk to public health from H5N8 as extremely low. Although already widespread in poultry in Asia, H5N8 infection has so far not been confirmed in people. However, the virus is highly pathogenic for domestic poultry species, causing severe clinical signs and high mortality in chickens and turkeys.

The detection of H5N8 HPAI in Europe is a reminder that avian influenza still represents a global threat to economies, trade and poultry-related livelihoods. FAO emphasizes the need for continued vigilance worldwide and heightened surveillance and biosecurity efforts, particularly on farms, to prevent contact between poultry and wild birds. 360

REFERENCE

Wu, H., Peng, X., Xu, L., Jin, C., Cheng, L., Lu, X., Xie, T., Yao, H, & Wu, N. 2014. Novel reassortant influenza A(H5N8) viruses in domestic ducks, eastern China. *Emerg. Infect. Dis.,* 20(8): http://dx.doi.org/10.3201/eid2008.140339.

[1] http://www.offlu.net/

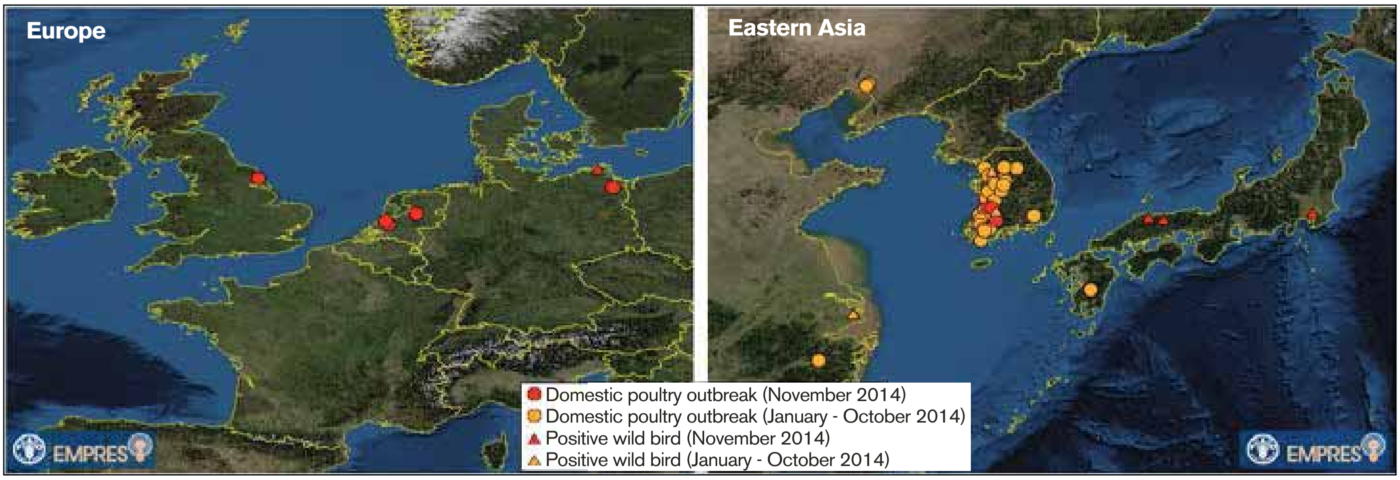


Figure 1: Highly pathogenic avian influenza H5N8 detected in Europe and eastern Asia in 2014
Source: EMPRES Global Animal Disease Information System (EMPRES-i). http://empres-i.fao.org/eipws3g/
Data in EMPRES-i are derived from numerous sources: FAO, OIE, official government sources, the European Commission, peer-reviewed publications, and FAO reference centres, laboratories and collaborators.

©FAO/Kai Wiedenhoefer

NEWS

Global foot-and-mouth disease control strategy: Fifth Meeting on the West Eurasia FMD Control Roadmap

Contributor: Samia Metwally **(FAO)**

Foot-and-mouth disease (FMD) has a huge global impact because it affects large numbers of animals, reduces livestock productivity and utility, decreases incomes by excluding livestock owners from potential markets, and incurs costs associated with control and eradication. The impact is of particular concern in developing countries, where the losses in production, utility and income can have a significant effect on livelihoods and food security.

In response to this challenge, the Food and Agriculture Organization of the United Nations (FAO), together with the World Organisation for Animal Health (OIE), has developed a 15-year global control strategy for FMD with the ultimate aim of improving FMD control in endemic settings and thereby reducing food insecurity and alleviating poverty in affected countries. The control strategy applies the progressive control pathway for FMD (PCP-FMD) and includes the development of regional roadmaps for countries sharing the same FMD virus pool.

Over the last two years, FAO and OIE have coordinated several regional meetings on these PCP-FMD roadmaps. The latest meeting, for West Eurasian countries, took place in Astana, Kazakhstan on 23 and 24 April 2014, and was conducted in collaboration with the European Commission for the Control of Foot-and-Mouth Disease (EUFMD) hosted by FAO. The meeting aimed to: i) share information among participants on the circulation of the FMD virus in West Eurasian countries; ii) review countries' progress along the PCP-FMD regional roadmap; and iii) assist countries in preparing national control programmes, project proposals for increased investments in FMD control, and submissions to OIE for programme endorsement. Participants came from 13 of the 14 West Eurasian countries: Afghanistan, Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Iraq, the Islamic Republic of Iran, Pakistan, the Syrian Arab Republic, Tajikistan, Turkey and Uzbekistan.

Before the meeting, participating countries filled out a PCP-FMD questionnaire for submission to the Global Framework for the Progressive Control of Transboundary Animal Diseases (GF-TADs) FMD working group. The working group assessed the stages in the PCP-FMD regional roadmap that countries had reached, and experts from FAO and OIE reviewed six risk-based control plans from countries moving to PCP-FMD stage 2. Final decisions regarding the PCP-FMD stages that other countries had reached were made by the Regional Advisory Group of West Eurasia. This exercise demonstrated that there has been significant progress in certain countries, but there are still many challenges to overcome.

Several countries requested guidance from FAO and OIE on preparing PCP-based project proposals to assist their national authorities in obtaining national and international investments in FMD control. Others requested FAO's assistance in conducting socio-economic analyses.

Key recommendations and calls for action were: i) each country must identify a PCP-FMD specialist, an epidemiologist and a laboratory specialist as focal points; ii) countries that are provisionally assigned to PCP-FMD stage 2 must submit their revised control plans for review by the GF-TADs FMD working group no later than October 2014; iii) the West Eurasia Epidemiological Network should encourage countries to harmonize and support the development of national and regional animal health information systems; and iv) national veterinary services will ensure that the vaccines used are appropriate for the viruses circulating in the region. 360

©FAO

Fifth Annual West Eurasia FMD Roadmap Meeting (Astana, Kazakhstan, 23–24 April 2014)

©FAO/A.K. Kimoto

NEWS

Laboratory and epidemiology training workshop to enhance preparedness for influenza A (H7N9) in at-risk African countries

Contributors: Guillaume Belot **(FAO)**, Ludovic Plee **(FAO)**, Sophie Von Dobschuetz **(FAO)**, Roberta Aiello **(IZSVe)**, Aurora Romero Tejeda **(IZSVe)**, Sam Okuthe **(FAO)**, Samuel Muriuki **(AU-IBAR)** and Berhanu Bedane **(FAO)**

CONTEXT

Since emergence of the novel influenza A(H7N9) virus in China in March 2013, the Food and Agriculture Organization of the United Nations (FAO) has been assisting at-risk countries in Asia and Africa in strengthening their preparedness for a potential incursion of the virus. In Africa, these efforts are coordinated under the Technical Cooperation Programme (TCP) project Emergency Assistance for Surveillance of Influenza A (H7N9) Virus in Poultry and other Animal Populations in Low- to Moderate-Risk Countries in Africa (TCP/RAF/3408 E). In the framework of this project, FAO, the African Union's Interafrican Bureau for Animal Resources (AU-IBAR) and the *Istituto Zooprofilattico Sperimentale delle Venezie* (IZSVe) held an epidemiology and laboratory training workshop on influenza A (H7N9) surveillance and diagnosis in Addis Ababa, Ethiopia from 26 to 30 May 2014.

Unlike H5N1, H7N9 causes no clinical signs in infected poultry, which complicates early detection of the virus through passive surveillance. There is therefore need to apply routine risk assessment exercises and to build effective and sustainable collaboration between epidemiology units and competent laboratories.

> "Epidemiologists and laboratory specialists from 11 African countries participated in the training, which was led by experts from FAO, IZSVe and AU-IBAR"

OUTCOMES

Epidemiologists and laboratory specialists from 11 African countries – Cameroon, Côte d'Ivoire, the Democratic Republic of the Congo, Egypt, Ethiopia, Ghana, Kenya, Nigeria, Senegal, the United Republic of Tanzania and Zambia – participated in the training, which was led by experts from FAO, IZSVe and AU-IBAR. These are the African countries considered to be at low to moderate risk of influenza A (H7N9) virus incursion based on three criteria: i) poultry trade links with China; ii) high-density poultry population; and iii) history of previous infection with influenza H5N1 virus. No country in Africa is considered to be at high risk.

The primary objective of the workshop was to impart basic skills and provide opportunities for collaboration among epidemiologists and laboratory experts at the national and regional levels. Discussions during joint sessions on the first and last days emphasized the importance of such

© Roberta Aiello

Participants and trainers at the laboratory and epidemiology training workshop in Addis Ababa, Ethiopia collaboration, the challenges encountered and ways of overcoming these challenges in the future. On the other three days, participants were split into two groups – epidemiologists and laboratory experts – and provided with training on risk assessment, risk communication, value chain analysis and risk-based surveillance for epidemiologists; and on collection, transport and laboratory diagnosis (serology and molecular biology) of field samples, basic laboratory biosafety, and virus isolation and characterization for laboratory experts.

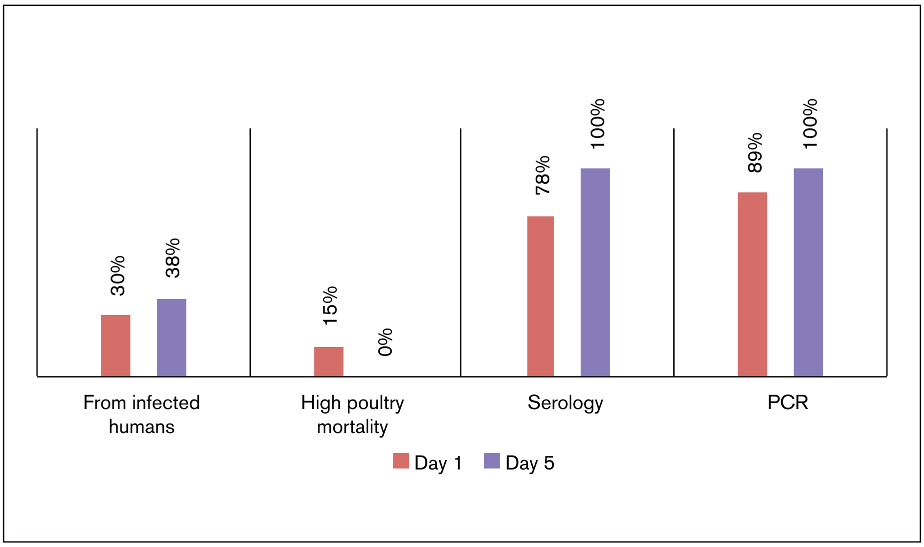
Epidemiology workshop sessions were delivered and facilitated by FAO and AU-IBAR officers and an independent communication expert. Live bird trade and movement of wild birds during migration were identified as the most likely routes for introduction of influenza A(H7N9) into African countries, with the risk level assessed as ranging from negligible/low to moderate. The importance of value chain analysis was emphasized, as it allows the identification of critical control points that can be targeted by surveillance and control measures. Because appropriate communication is essential during the whole risk analysis process, guidance was provided on how to improve the communication of uncertainty, diagnose the public's fear or outrage, and avoid over-reassurance, even when tempting. Participants undertook practical exercises, including conducting a risk assessment for their respective countries, developing a risk-based surveillance programme with limited funds in a fictional country, and preparing a communiqué for the general public.

The laboratory experts were trained in diagnosis of H7N9, including appropriate testing protocols and algorithms, at the National Animal Health Diagnostics and Investigation Center (NAHDIC), Ethiopia's veterinary reference laboratory for avian influenza. Laboratory training was conducted by experts from IZSVe in theoretical and practical sessions. Theoretical sessions covered the characteristics, application, strengths and limitations of each of the diagnostic techniques that can be used for identifying and diagnosing H7N9. Differential diagnoses of avian influenza and the importance of laboratory biosafety were also discussed. During practical sessions, the trainers demonstrated diagnostic methods for antibody detection, such as haemagglutination inhibition (HI) and enzyme-linked immunosorbent assay (ELISA); virus detection, such as real-time reverse transcription polymerase chain reaction (PCR); and virus isolation through egg inoculation. The national laboratory experts then practised these tests on their own. Training also included discussion of the correct interpretation of results from the diagnostic methods demonstrated, and a practical session on collecting tracheal and cloacal swabs and blood samples from poultry.

As several countries are already engaged in controlling other diseases of importance, and as the risk level for influenza A(H7N9) introduction is currently assessed as negligible to low for most countries, trainers demonstrated how the methodologies presented for risk assessment, risk management, risk communication, risk-based surveillance and laboratory protocols can be adapted and used for other zoonotic or animal diseases and how existing surveillance efforts can be utilized to screen and prepare for H7N9. Participants' knowledge was evaluated on the first and last days of the workshop. When asked to list three words that came to mind when they thought about H7N9, participants demonstrated a clear evolution from passive reaction (with answers such as "fear", "death" or "pandemic" on the first day) to a proactive, action-oriented attitude (with answers such as "preparedness", "surveillance" or "contingency" on the last). Participants were also motivated to apply their newly acquired skills in their national contexts of disease prevention and control, and increased their knowledge of how to detect infected poultry (Figure 1). 360

© FAO

Epidemiology and laboratory training workshop on influenza A (H7N9) surveillance and diagnosis, Addis Ababa, Ethiopia (26 – 30 May 2014)



| **Figure 1:** Evolution of participants' responses when asked how they would detect infected poultry

©FAO

NEWS

First coordination meeting of a regional animal health network for Central Africa

Contributors: Gwenaëlle Dauphin **(FAO)** and Charles Bebay **(FAO)**

The Emergency Centre for Transboundary Animal Disease Operations (ECTAD) in Bamako, Mali and the Economic Commission on Cattle, Meat and Fish Resources in the Economic Commission on Cattle, Meat and Fish Resources (CEBEVIRHA) in the Central African Economic and Monetary Community (CEMAC) jointly organized the first coordination meeting of the Central African regional networks for epidemiological surveillance (RESEPI-CA) and veterinary laboratories (RESOLAB-CA). The meeting was held at CEBEVIRHA's facilities in N'Djamena, Chad from 24 to 28 March 2014.

The opening ceremony was chaired by the Minister of Agriculture and Irrigation of Chad and attended by the Commissioner for Infrastructure and Sustainable Development of CEMAC, the Regional Representative for Africa of the World Organisation for Animal Health (OIE), the Representative of the Food and Agriculture Organization of the United Nations (FAO) in Chad, the Director-General of CEBEVIRHA, the Chief Animal Health Officer of the African Union's Interafrican Bureau for Animal Resources (AU-IBAR), a representative of the Director-General of the AU's Pan African Veterinary Vaccine Centre (AU-PANVAC), the Director of the Inter-State School of Veterinary Science and Medicine of Dakar (EISMV), and a representative of the United States Department of Agriculture (USDA) regional office.

About 50 people participated in the meeting, including chief veterinary officers (CVOs), focal points of national epidemio-surveillance networks and directors of veterinary laboratories from Cameroon, the Central African Republic, Chad, the Congo, Gabon and the Democratic Republic of the Congo; and representatives of the Economic Community of Central African States (ECCAS), CEBEVIRHA, OIE, AU-IBAR, AU-PANVAC, EISMV, the *Istituto Zooprofilattico Sperimentale delle Venezie* (IZSVe), USDA and FAO's Emergency Prevention System (EMPRES) Laboratory Unit (at Headquarters, Rome, Italy), ECTAD Bamako (Mali) and ECTAD Nairobi (Kenya).

©FAO

First coordination meeting of the Central African regional networks for epidemiological surveillance (RESEPI-CA) and veterinary laboratories (RESOLAB-CA) (N'Djamena, Chad, 24–28 March 2014)

This first meeting in Central Africa followed the decisions taken in September 2012 (in Accra, Ghana) and December 2012 (in Dakar, Senegal) to establish joint RESEPI/RESOLAB networks for West Africa and Central Africa, with the aim of facilitating the institutionalization of RESEPI and RESOLAB within the relevant regional economic communities. It was held under the auspices of the Global Framework for the Progressive Control of Transboundary Animal Diseases in Africa (GF-TAD Africa).

During the five days of the meeting, participants discussed the activities of diagnostic laboratories and national networks for disease surveillance and developed a three-year RESEPI-CA/RESOLAB-CA programme, including a roadmap for the designation of regional support laboratories in Central Africa. Participants agreed to establish a regional veterinary committee for Central Africa composed of the CVOs of ECCAS member States.

The regional animal health centre to be established by CEBEVIRHA with support from technical partners should foster implementation of the multi-year RESEPI-CA/RESOLAB-CA programme.

Participants also agreed to develop a charter to make the network more efficient, based on clear and unambiguous rules.

The host countries for subsequent coordination meetings will be selected according to the alphabetical order of countries' names. The next RESEPI-CA/RESOLAB-CA meeting will therefore be held in Cameroon, in March 2015 as stated in the meeting's final communiqué[1]. 360

[1] http://www.fao-ectad-bamako.org/fr/IMG/pdf/Communique_final_Ndjamena_final.pdf

© J. Y. Piel

NEWS

Launching of a project for African swine fever preparedness in China

Contributors: Wang Zhiliang **(CAHEC)**, Daniel Beltran-Alcrudo **(FAO)**, John Edwards **(FAO)**, Jiang Han **(FAO)**, Guo Fusheng **(FAO)**, Li Shuo **(China Animal Disease Prevention and Control Center, CADC)**, Wang Gongmin **(Veterinary Bureau, Ministry of Agriculture, China)**, Song Junxia **(Veterinary Bureau, Ministry of Agriculture, China)**, Zhao Lijun **(Department of International Cooperation, Ministry of Agriculture, China)**, Carolyn Benigno **(FAO)** and Juan Lubroth **(FAO)**

On 4 July 2014, a Technical Cooperation Programme (TCP) project[1] was launched in Beijing, China on prevention and control strategies for African swine fever (ASF). The project is a response to increasing concern regarding the potential for ASF spread into East Asia, particularly China, which has almost half of the world's domestic pig population. It also represents an important landmark in collaboration between the Food and Agriculture Organization of the United Nations (FAO) and the Government of China in preventing and controlling transboundary animal diseases.

ASF is a highly contagious haemorrhagic fever of domestic pigs and wild boar, which can result in up to 100 percent mortality. The catastrophic effect of the disease on trade and on pig production (from the household to the commercial level) has serious socio-economic consequences and implications for food security. The lack of an effective vaccine makes ASF control very costly and challenging, as the only available tools are stamping out, strict movement control, biosecurity improvement and raising of stakeholder awareness. As ASF has high mortality and is transboundary, ASF-free countries have to develop efficient early warning systems and preparedness plans to prevent and respond to its introduction.

Given the potential global spread of ASF infection, the difficulties of control in affected countries, and the risk of introduction as a result of cross-border movement of infected animals (wild and domestic) and meat – in amounts that range from large shipments in containers to a few hundred grams in personal luggage – most countries currently free of the infection are taking serious measures to tighten their border controls and strengthen their systems for early warning, prevention and control.

The possibility of ASF transmission into China is a great concern. The disease is endemic in most African countries with pig production, and continues to spread into new areas as a result of increased pig numbers and movements. ASF is also spreading in Eastern Europe, where it is on the way to becoming endemic having first entered the Caucasus in 2007. It is important to note that this is not the first time that ASF virus (ASFV) has jumped from Africa; previous incursions into countries of Europe and the Americas occurred between the 1950s and the 1980s. The cross-border spread of ASFV into China is a possibility because China shares a 4 300-km border with the Russian Federation, with opportunities for infected pork products, live pigs or wild boar to cross the border by land. However, the likelihood of entry by this route is reduced by the long distances concerned, the small pig populations in Central Asian countries and Mongolia, and

© Lu Feng

Inception workshop of FAO TCP project "Developing Prevention and Control Strategies for African Swine Fever in China" (Beijing, 4 July 2014)

[1] TCP/CPR/3501

the presence of deserts, mountains and other barriers between the current epidemic area in the Russian Federation and China.

As the Chinese Government has banned the import of pigs or pig products from ASF-infected countries, the highest risk of disease incursion stems from increased international travel and the possibility of illegal imports/smuggling of pork. Very large numbers of travellers cross borders, with many carrying pork and other potentially contaminated products in their luggage. In recent years, China's involvement in African development interventions, including the provision of massive labour forces, has led to increased exchanges of people and goods with ASF-endemic countries. The potential involvement of visitors or workers returning to China – which is now the country from which the highest number of tourists travel overseas – should also not be underestimated. Food waste from aircraft and ships has also been shown to be an important means of historical introduction (as in Brazil, Georgia and Portugal), and this risk source should be closely examined. The risk stems from ASFV's capacity to remain viable in pork and other pig products for long periods. The most likely scenario for contaminated pork entering a country and transmitting infection to susceptible hosts is through swill feeding, which is a common practice where the pig sector is dominated by backyard production systems with low biosecurity. An alternative route would be through access to garbage for scavenging pigs or wild boar.

China has the largest pig population in the world, accounting for about 50 percent of global swine production. The main pig production areas, which account for more than 80 percent of national output, are concentrated in 12 provinces along the Yangtze River, and in north China and some major grain producing areas. China's pig industry includes both intensive and backyard production systems, but production from large, intensive pig farms accounts for only 15–20 percent of output, so a large proportion of farms have low biosecurity levels which would seriously complicate control of the disease. In addition, the well-developed highway system allows the movement of pigs from one province to most other provinces within a few days, greatly increasing the potential spread of ASF if index cases are not found early. An incursion of ASF virus into China may lead to further spread of the disease to neighbouring countries in Asia, with a severe economic impact across the world.

> “With the increased ASF virus circulation worldwide, i.e. ASF is endemic in sub-Saharan Africa and parts of Eastern Europe, the risk for China is at its highest”

Since ASF was introduced into the Caucasus in 2007, China has paid great attention to its evolution and potential for introduction into China, recognizing it as the country's top priority exotic animal disease. National scientific researchers based at the China Animal Health and Epidemiology Center (CAHEC) have been taking the lead in establishing strategies to prevent, detect and control ASF, including by developing rapid diagnostic techniques, carrying out active surveillance in risk areas, preparing contingency plans, and organizing training for provincial staff on ASF prevention and control.

The TCP project aims to support the national government in preventing an incursion of ASF, and in quickly detecting and controlling its spread should such an incursion occur. More specifically, the project will improve the overall national level of preparedness for ASF through capacity-building activities on risk assessment, diagnostic techniques and epidemiology, and awareness campaigns for farmers and veterinarians. It will focus on organizing in-country training activities to improve the capacity for diagnosis, risk assessment, active surveillance and outbreak investigation at the national and provincial levels, and will assist in refining the national contingency plan. The project will also contribute to strengthening the national ASF laboratory coordination mechanism and networking. Project activities will facilitate the exchange of experience and expertise between national experts and international peers. 360

© Li Shuo

Group discussion on ASF outbreak investigation during ASF TCP epidemiology and risk assessment training

CONTACTS @ HQ

FAO-EMPRES, Rome, Italy
fax: (+39) 06 57053057
e-mail: empres-animal-health @fao.org

Edgardo Arza
Veterinary Planning and Response Coordinator (CMC-AH)
tel: (+39) 06 57054937
e-mail: edgardo.arza@fao.org

Guillaume Belot
Veterinary Epidemiologist
tel: (+39) 06 57054878
e-mail: Guillaume.Belot@fao.org

Daniel Beltrán-Alcrudo
Animal Health Officer (Disease Ecology)
tel: (+39) 06 57053823
e-mail: daniel.beltranalcrudo@fao.org

Filip Claes
Laboratory Microbiologist,
EMPRES Laboratory Unit
tel: (+39) 06 57053525
e-mail: filip.claes@fao.org

Gwenaëlle Dauphin
Lead, EMPRES Laboratory Unit
OFFLU focal point
tel: (+39) 06 57056027
e-mail: gwenaëlle.dauphin@fao.org

Ian Douglas
Senior Officer
Crisis Management Centre - Animal Health (CMC-AH) Manager
tel: (+39) 06 57055184
e-mail: ian.douglas@fao.org

Katinka de Balogh
Senior Officer (Veterinary Public Health)
tel: (+39) 06 57056110
e-mail: katinka.debalogh@fao.org

Ahmed El Idrissi
Senior Officer (Bacterial and Zoonotic Diseases)
Lead, Programming Unit
tel: (+39) 06 57053650
e-mail: ahmed.elldrissi@fao.org

Giancarlo Ferrari
Animal Health Technical Expert
tel: (+39) 06 57056691
Giancarlo.Ferrari@fao.org

Akiko Kamata
Animal Health Officer
tel: (+39) 06 57054552
e-mail: akiko.kamata@fao.org

Sergei Khomenko
Disease Ecology / Wildlife
tel: (+39) 06 57056493
e-mail: sergei.khomenko@fao.org

Fairouz Larfaoui
Disease Intelligence / GLEWS/FAO
tel: (+39) 06 57053331
e-mail: fairouz.larfaoui@fao.org

Caryl Lockhart
Veterinary Epidemiologist / GLEWS/FAO
tel: (+39) 06 57054946
e-mail: caryl.lockard@fao.org

Raffaele Mattioli
Senior Officer (Non-Infectious Diseases)
tel: (+39) 06 57056078
e-mail:raffaele.mattioli@fao.org

Samia Metwally
Animal Health Officer (Virology)
tel: (+39) 06 57055838
e-mail: samia.metwally@fao.org

Béatrice Mouillé
EMPRES Laboratory Unit, Assistant Coordinator
tel: (+39) 06 57054456
e-mail: beatrice.mouille@fao.org

Cecilia Murguia
Information Management
tel.: (+39) 06 57056520
e-mail: cecilia.murguia@fao.org

Felix Njeumi
Animal Health Officer (Disease Management)
tel: (+39) 06 57053941
e-mail: felix.njeumi@fao.org

Patrick Otto
Animal Health Officer (Veterinary Public Health)
tel: (+39) 06 57053088
e-mail: patrick.otto@fao.org

Elisa Palamara
Data Management
tel: (+39) 06 57055124
Elisa.Palamara@fao.org

Julio Pinto
Animal Health Officer (Epidemiology)
Global Early Warning System (GLEWS/FAO)
tel: (+39) 06 57053451
e-mail: julio.pinto@fao.org

Claudia Pittiglio
Disease Ecology (Spatial Modelling)
tel: (+39) 06 57056371
e-mail: Claudia.Pittiglio@fao.org

Ludovic Plee
Veterinary Epidemiologist / CMC-AH
tel: (+39) 06 57055206
e-mail: ludovic.plee@fao.org

Eran Raizman
Senior Officer
Head, EMPRES
tel: (+39) 06 57052360
e-mail: Eran.Raizman@fao.org

Keith Sumption
Secretary
European Commission for the Control of Foot-and-Mouth Disease (EUFMD)
tel: (+39) 06 57055528
e-mail: keith.sumption@fao.org

Sophie von Dobschuetz
Veterinary Epidemiologist
tel: (+39) 06 57053717
e-mail: sophie.vondobschuetz@fao.org

James Zingeser
Veterinary Epidemiologist (Zoonoses)
tel: (+39) 06 57055918
e-mail: james.zingeser@fao.org

CONTACTS @ Joint FAO/IAEA Division

Adama Diallo
Head, Animal Production and Health Laboratory
Seibersdorf, Austria
tel: (+43) 1 2600 28355
e-mail: adama.diallo@iaea.org

Gerrit Viljoen
Head, Animal Production and Health Section
Vienna, Austria
tel: (+43) 1 260026053
e-mail: g.j.viljoen@iaea.org

CONTACTS @ AFRICA

Charles Bebay
Regional Manager a.i
Emergency Centre for Transboundary Animal Disease Operations (ECTAD)
Western and Central Africa
Regional Animal Health Centre for West and Central Africa
Bamako, Mali
tel: (+ 223) 20 24 92 93
e-mail: Charles.Bebay@fao.org

Berhanu Bedane
Animal Production and Health Officer
FAO Regional Office for Africa - West Africa Team
Accra, Ghana
tel: (+233) 0302675000/ 0307010930 ext. 3144
e-mail: behanu.bedane@fao.org

Mohammed Bengoumi
Animal Production and Health Officer
FAO Sub-Regional Office for North Africa
Tunis, Tunisia
tel: (+216) 71903236 ext. 236
mohammed.bengoumi@ fao.org

Oumar Diall
Animal Production and Health Officer
FAO Sub-Regional Office for Eastern Africa
Addis Ababa, Ethiopia
tel: (+251) 11 5517230/33
e-mail: oumar.diall@fao.org

Bouna Diop
Regional Manager
Emergency Centre for Transboundary Animal Disease Operations (ECTAD)
Eastern Africa
Regional Animal Health Centre for East Africa
Nairobi, Kenya
tel: (+254) 20 7625926
e-mail: bouna.diop@fao.org

Cheikh Ly
Animal Production and Health Officer
FAO Regional Office for Africa
Accra, Ghana
tel: (+233) 0302 675000 ext. 2502
e-mail: cheikh.ly@fao.org

CONTACTS @ Europe and Central Asia

Abdulbaqi Mehraban
Animal Production and Health Officer
FAO Subregional Office for Central Asia
Ankara, Turkey
tel: (+90) 312 3079500
e-mail: abdulbaqi.mehraban@fao.org

Andriy Rozstalnyy
Animal Production and Health Officer
FAO Regional Office for Europe and Central Asia. Budapest, Hungary
tel: (+ 36) 1 4612025
e-mail: Andriy.Rozstalnyy@fao.org

CONTACTS @ Latin America and the Caribbean

Deyanira Barrero León
Regional Coordinator for Foot-and-Mouth Disease
Santiago, Chile
tel: (+56) 2 9232206
e-mail: deyanira.barrero@fao.org

Tito E. Díaz Muñoz
Senior Animal Production and Health Officer
FAO Regional Office for Latin America and the Caribbean. Santiago, Chile
tel: (+56) 2 3372250
e-mail: tito.diaz@fao.org

Cedric Lazarus
Livestock Development Officer
Sub-Regional Office for the Caribbean
Bridgetown, Barbados
tel: (+246) 4267110 ext. 245
e-mail: cedric.lazarus@fao.org

CONTACTS @ Near East

Nacif Rihani
Livestock Development Officer
Sub-Regional Office for the Gulf Cooperation Council States and Yemen
Abu Dhabi, United Arab Emirates
tel: (+971) 2 6586774
e-mail: Nacif.Rihani@fao.org

Markos Tibbo
Livestock Officer
Animal Production and Health Officer, OiC.
FAO Regional Office for the Near East
Cairo, Egypt
tel: (+202) 3331 6143/6000 ext. 2803
e-mail: markos.tibbo@fao.org

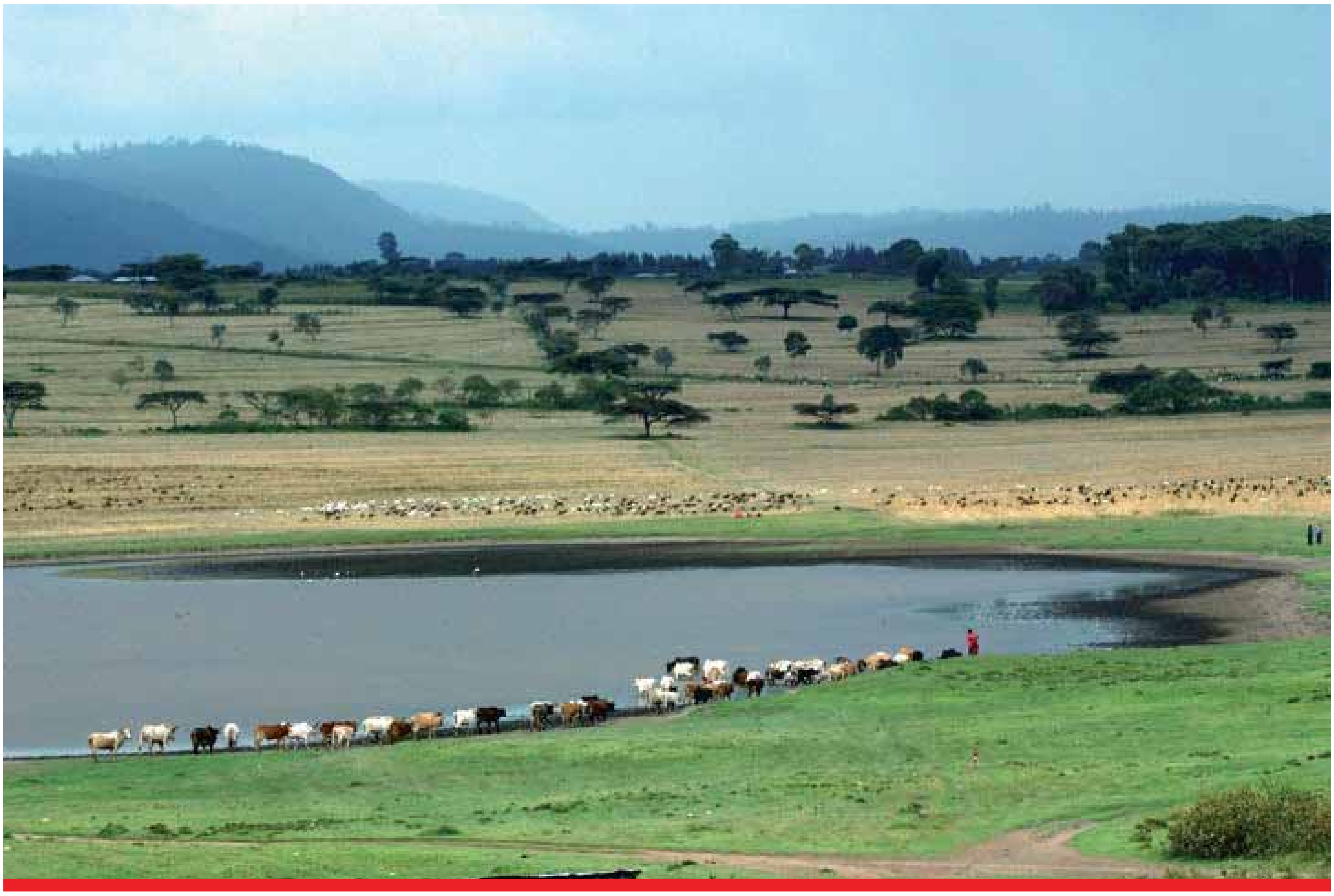
Yilma Jobre Makonnen
Team Leader
ECTAD Egypt
Cairo, Egypt
tel: (+20) 23 3316000 ext. 2511
e-mail: yilma.makonnen@fao.org

CONTACTS @ Asia

Carolyn Benigno
Animal Health Officer
FAO Regional Office for Asia and the Pacific,
Bangkok, Thailand
tel: (+66) (0)2 6974330
e-mail: carolyn.benigno@fao.org

Wantanee Kalpravidh
ECTAD Regional Manager
Emergency Centre for Transboundary Animal Disease Operations (ECTAD) Asia and the Pacific
Bangkok, Thailand
tel: (+66) (0)2 (697) 4231
e-mail: wantanee.kalpravidh@fao.org

Joachim Otte
Senior Animal Production and Health Officer
Secretary of the Animal Production and Health Commission Asia and the Pacific (APHCA)
FAO Regional Office for Asia and the Pacific,
Bangkok, Thailand
tel: (+66) (0)2 6974326
e-mail: joachim.otte@fao.org



empres360 animal health **CONTACT**

The Emergency Prevention System (EMPRES) is an FAO programme, founded in 1994, with the goal of enhancing world food security, fighting transboundary animal and plant pests and diseases and reducing the adverse impact of food safety threats. EMPRES-Animal Health is the component dealing with the prevention and control of transboundary animal diseases (TADs).

To subscribe or to ask for information about EMPRES-Animal Health send an e-mail to: **empres-animal-health@fao.org** or a fax to **(+39) 06 57053023**

For more information visit us at **http://www.fao.org/ag/empres.html**

EMPRES-Animal Health can assist countries in the shipment of samples for TAD diagnostic testing at a FAO reference laboratory and reference centre. Please contact **Empres-Shipping-Service@fao.org** for information prior to sampling or shipment. Please note that sending samples out of a country requires an export permit from the Chief Veterinarian's Office of the country and an import permit from the receiving country.

Recommended citation
FAO. 2014. *EMPRES-Animal Health 360*, No. 44. Rome

Main photo front cover: ©FAO/Jim Holmes
Photo back cover: ©FAO/Ami Vitale

The designations employed and the presentation of material in this information product do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations (FAO) concerning the legal or development status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. The mention of specific companies or products of manufacturers, whether or not these have been patented, does not imply that these have been endorsed or recommended by FAO in preference to others of a similar nature that are not mentioned.

The views expressed in this information product are those of the author(s) and do not necessarilyreflect the views or policies of FAO.

© FAO, 2014

FAO encourages the use, reproduction and dissemination of material in this information product. Except where otherwise indicated, material may be copied, downloaded and printed for private study, research and teaching purposes, or for use in non-commercial products or services, provided that appropriate acknowledgement of FAO as the source and copyright holder is given and that FAO's endorsement of users' views, products or services is not implied in any way.

All requests for translation and adaptation rights, and for resale and other commercial use rights should be made via www.fao.org/contact-us/licence-request or addressed to copyright@fao.org.

FAO information products are available on the FAO website (www.fao.org/publications) and can be purchased through publications-sales@fao.org

I4257E/1/12.14