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Bovine tuberculosis at the animal–human–ecosystem interface

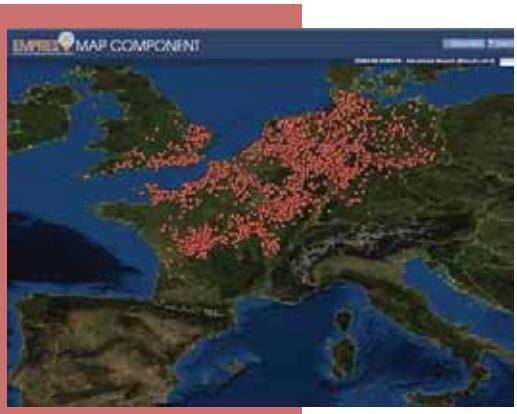
Bovine tuberculosis commands growing attention from the international community. The disease continues to cause significant losses in the cattle farming sector with serious implications on public health, especially in countries where surveillance and control programmes are weak or non-existent. The permanent threat of infection from animal reservoirs represents a continuous threat and source of infection of cattle, making complete eradication difficult in many developed countries. In response to the global importance of bovine tuberculosis, the Food and Agriculture Organization of the United Nations (FAO) has recognized it as a serious infectious disease that should be controlled at the animal–human–ecosystem interface, in the interest of the livestock industry, public health and human livelihoods (page 2).

Foot-and-mouth disease in Egypt, Libya and the Gaza Strip: crisis and response

Since February 2012, a severe foot-and-mouth disease (FMD) SAT2 epidemic has spread through Egypt and into the Gaza Strip. A separate outbreak of SAT2 has been detected in Libya. FAO and the European Commission for the Control of Foot-and-Mouth Disease (EuFMD) have developed a regional strategic plan for dealing with SAT2, with the aim of containing spread to neighbouring countries and reducing the impact in affected areas. Implementation of this strategic plan has begun. A regional response is required for the medium and long terms, to prevent further damage to livestock, livelihoods and food security (page 12).

AND...

Schmallenberg virus: a new virus threatening livestock farming in Europe



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In mid-December 2011, a novel vector-borne orthobunyavirus, the Schmallenberg virus (SBV), was identified in Europe. As of June 2012, cases of congenital malformations and stillbirths attributed to this new virus were reported in Belgium, France, Germany, Italy, Luxembourg, the Netherlands, Spain and the United Kingdom of Great Britain and Northern Ireland. FAO, the World Organisation for Animal Health (OIE) and the World Health Organization (WHO) closely monitored the situation of SBV in animals and the potential implications for animal and human health. The evidence to date indicates that there are no human cases associated with the animal cases in the countries affected (page 17).

Tuberculosis

Bovine tuberculosis at the animal–human–ecosystem interface

Introduction

Bovine tuberculosis is a chronic disease of animals caused primarily by *Mycobacterium bovis (M. bovis),* a member of the *M. tuberculosis* complex. The disease is characterized by progressive development of specific granulomatous lesions or tubercles in lung tissue, lymph nodes or other organs. The incubation period ranges from months to years, but acute stages of the disease can develop during the course of infection, when lesions progress rapidly.

Bovine tuberculosis is an important disease in livestock and in a wide range of wild animal species worldwide. Bovine species, including bison and buffaloes, are particularly susceptible to the disease, but nearly all warm-blooded animals can be affected. *M. bovis* is also known to affect humans, causing a serious public health problem when it becomes endemic.

Similar to the human form of tuberculosis, bovine tuberculosis is commanding growing attention from the international community. This is because of the serious increase in the number of infected herds and the subsequent effect on animal production, combined with the significant impact of *M. bovis* infection on public health, and the permanent threat of infection from animal reservoirs. Despite the long history of disease recognition, the epidemiology of *M. bovis* is not well understood, especially in wildlife. In some developed countries, the disease has been eliminated from the livestock population, but in other countries wildlife species have been identified as reservoir hosts, representing a continuous threat and source of infection of cattle and making complete eradication difficult. In less developed countries, the disease is maintained in bovines and continues to cause significant losses in the cattle farming sector, with serious implications for public health, especially where there is no effective surveillance and control programmes are weak or non-existent. In response to the global importance of bovine tuberculosis for both animal and public health, the Food and Agriculture Organization of the United Nations (FAO) has recognized it as a priority infectious disease that should be controlled at the animal–human–ecosystem interface, through national and regional efforts.

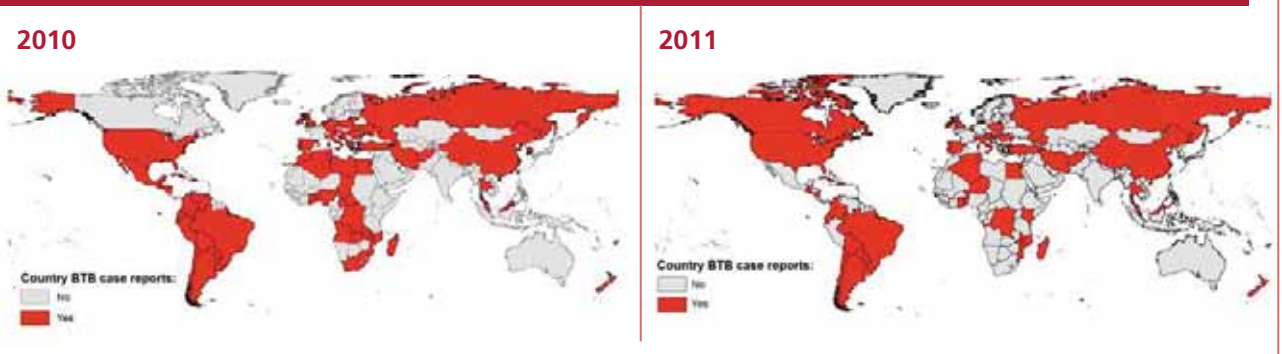
Bovine tuberculosis is an important disease in livestock and in a wide range of wild animal species worldwide

This article does not aim to provide a comprehensive description of bovine tuberculosis, which can be found elsewhere (Michel, Müller and van Helden, 2010; Thoen *et al.*, 2009), but rather to outline the main features of bovine tuberculosis in cattle and wildlife, the impact of the disease on public health, and perspectives on its control, with particular reference to the situation in developing countries.

Global distribution and socio-economic impact

The geographical distribution of bovine tuberculosis has changed drastically over recent decades. Prior to the introduction of control measures and milk pasteurization in developed countries, tuberculosis was widely distributed throughout the world. Eradica-

Figure 1: Geographical distribution of bovine tuberculosis (BTB) for 2010 and 2011 based on OIE six monthly reports



Source: OIE WAHID adapted by FAO EMPRES-i.

tion programmes based on surveillance and test-and-slaughter policies to clear herds of infected animals virtually eliminated tuberculosis from livestock in many developed countries. Today, many countries in Europe and North America, and Australia are free of the disease or close to its complete eradication in livestock. However, the maintenance of *M. bovis* infection in wildlife species has significantly compromised eradication efforts in countries such as Ireland, New Zealand, the United Kingdom of Great Britain and Northern Ireland and parts of the United States of America (Thoen *et al.,* 2009).

In developing countries, data on the prevalence of bovine tuberculosis are minimal, and the information available may not represent the true epidemiological status of the disease. Although bovine tuberculosis is notifiable in many countries, it is often underreported, particularly in countries that lack effective disease surveillance and reporting systems. The insidious nature of the disease, which does not cause fulminating outbreaks with high mortality, is likely to decrease recognition and reporting, leading to a lack of measures for its control.

Despite disease underreporting in developing countries, however there is sufficient evidence to indicate not only that the prevalence of disease is higher in the developing nations, but also that in the absence of national control and eradication programmes, it is increasing worldwide, particularly in Africa, Asia and Latin America (Thoen *et al.,* 2009). According to the World Animal Health Information Database (WAHID) of the World Organisation for Animal Health (OIE), 70 countries reported bovine tuberculosis cases in their cattle populations in 2010, and 49 countries in 2011 (Figure 1).

The economic impact of bovine tuberculosis on livestock production is extremely difficult to determine accurately. The disease decreases livestock productivity and may be economically devastating for the cattle industry, especially the dairy sector. Milk yields and draft power can be significantly reduced, with direct effects on the livelihoods of poor livestock holders. Most important is the impact of infection in humans – particularly women and children, who appear to be more susceptible to the disease – in countries with poor socio-economic conditions and weak veterinary and public health services. Although estimates of the costs associated with bovine tuberculosis and its

control refer only to specific countries, all data suggest that worldwide economic losses due to the disease are significant. These losses include those related to animal production, markets and trade, as well as the costs of implementing surveillance and control programmes. Losses to tuberculosis are also extremely important when endangered wildlife species are involved.

Impact of *M. bovis* infection on human health

Bovine tuberculosis is a zoonotic disease that can have serious consequences for public health. Transmission of *M. bovis* from cattle to humans was once common in developed countries, but human infections have been virtually eliminated in countries with effective programmes for eradicating the disease in cattle, and high standards of food safety, particularly the pasteurization of milk. The incidence of human tuberculosis due to *M. bovis* varies considerably among countries, depending on the prevalence of the disease in cattle, socio-economic conditions, consumer habits, and food hygiene practices. In developed countries, *M. bovis* generally accounts for an insignificant share of total tuberculosis cases in humans. It causes less than 2 percent of all tuberculosis cases in the United States of America (CDC, 2011), and has been estimated to cause less than 1.5 percent of confirmed human cases in the United Kingdom of Great Britain and Northern Ireland (de la Rua-Domenech, 2006). In the Netherlands, *M. bovis* infection represented about 1.4 percent of all tuberculosis cases during 1993 to 2007 (Majoor *et al.,* 2011).

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A woman farmer milking a cow, Tajikistan

In developing countries, the occurrence of human tuberculosis due to *M. bovis* is difficult to determine accurately, and probably remains underreported owing to the diagnostic limitations of many laboratories in isolating the microorganism and distinguishing *M. bovis* from *M. tuberculosis*. Prevalence of the disease is likely to be higher in countries where *M. bovis* infection is endemic in cattle, and milk is not routinely pasteurized. Some reports have speculated that *M. bovis* accounts for 10 to 15 percent of human tuberculosis cases (Cosivi *et al.,* 1998), while other estimates range from 0.4 to 8 percent, demonstrating that *M. bovis* is an important factor in human tuberculosis (Grange, 2001). Consumption of untreated dairy products from infected cows is the usual mode of transmission of tuberculosis from animals to people. This mode is particularly dangerous for children, who appear to be most susceptible to the disease in rural areas. The infection can also occur through airborne transmission, especially where humans work in the immediate vicinity of infected cattle or carcasses and/or share premises with infected animals. People suffering from *M. bovis* tuberculosis can retransmit the infection to cattle, but this is not common. Mounting evidence supports the likelihood of human-to-human airborne transmission of *M. bovis* from patients with pulmonary disease, but the relative contribution of this mode to new infections in humans is unknown (LoBue, LeClair and Moser, 2004).

As is also true of *M. tuberculosis* infection, the risk of *M. bovis* infection in humans is likely to increase where HIV/AIDS prevalence is high, because immunosuppressed AIDS

patients are susceptible. Cases of HIV-related human tuberculosis due to *M. bovis* have been reported in many developed countries (WHO, 1994). The potential impact of an AIDS pandemic or HIV infections in humans on the transmission of *M. bovis* to and among humans is of great concern and requires careful consideration wherever bovine tuberculosis is still a major problem (WHO, 1994; Grange, 2001).

Tuberculosis in wildlife

Bovine tuberculosis has emerged as an increasingly important disease of both captive and free-ranging wildlife populations. Tuberculosis in wildlife increases public health concerns and interferes with tuberculosis eradication programmes in cattle. *M. bovis* can infect a wide range of wild animals, which can act as either reservoir hosts, capable of maintaining and spreading the infection by intra-species transmission, or spill-over hosts, when infection is not maintained in the wildlife population. The range of wild animal hosts and reservoirs of infection varies among regions. The African buffalo (*Syncerus caffer*) is considered to be a maintenance host for *M. bovis* in South Africa's Kruger National Park (Michel, Müller and van Helden, 2010), with infection spill-over to other wildlife species in the park (de Vos *et al.,* 2001). Wapiti (*Cervus elaphus*) and bison (*Bison bison*) are considered wildlife reservoirs of *M. bovis* infection in Canada (Nishi, Shury and Elkin, 2006); the white-tailed deer population is the first acknowledged wildlife reservoir of bovine tuberculosis in the United States of America (de Lisle *et al.,* 2002); European badger (*Meles meles*) populations are reservoir hosts in Ireland and the United Kingdom of Great Britain and Northern Ireland (Corner, 2006); and brushtail possums (*Trichosurus vulpecula*) are the primary wild maintenance hosts of bovine tuberculosis in New Zealand (Nugent, 2011). Tuberculosis in captive deer or wild cervids has been observed in many countries in Europe and North America. There is increasing evidence that wild boars (*Sus scrofa*), long thought to be spill-over hosts, are actually maintenance hosts of *M. bovis* for other wildlife and domestic animals in Europe (Parra *et al.,* 2008). Wildlife may contaminate cattle by direct or indirect contact, and many questions remain regarding wildlife and *M. bovis* transmission at the livestock interface. Although direct transmission is probably rare, it may be possible when infected animals are at a late stage of the disease. Indirect transmission is more frequent through contamination of the environment, water and feed by excretions of wildlife.

Bovine tuberculosis has emerged as an increasingly important disease of both captive and free-ranging wildlife populations

Options for control and eradication of bovine tuberculosis

Control and eradication of bovine tuberculosis is a desirable objective both from an animal health perspective and because of the zoonotic implications of *M. bovis*. Control and eradication have been achieved in many countries through test-and-slaughter policy combined with abattoir surveillance.

Surveillance of bovine tuberculosis, and testing tools

The tuberculin skin test is the standard testing tool for detecting tuberculosis in live animals and is the primary cattle screening tool currently available. It is referred to

as a single intradermal test when bovine tuberculin is used alone, and an intradermal comparative test when both bovine and avian tuberculins are used. The latter can distinguish between infections with *M. bovis* and sensitization to other Mycobacteria species. The tuberculin skin test has been widely applied for screening in eradication campaigns, with successful results in many countries. Nevertheless, the test has limitations, including difficulties in interpreting results and imperfect test accuracy. This lack of performance, particularly when infected animals are not picked up, can impede progress in a herd sanitation programme using test and slaughter. Unnecessary elimination of false positive reactors may also have serious implications on cattle management. Additional limitations are related to the time, expense and stress of handling cattle multiple times. The test requires 72 hours between administration of the tuberculin and reading of the reaction, so cattle have to be handled twice.

Several other tests have been developed to improve diagnosis and screening of bovine tuberculosis. Among these is the interferon gamma assay, which detects the production of gamma interferon by the T lymphocytes in the blood. Studies on the specificity of this test have contributed to significant improvements in the detection of *M. bovis* in cattle and wildlife populations. However, the interferon gamma assay is not used routinely for diagnosis of bovine tuberculosis and appears to be impractical for use in developing countries, as it requires delivery of samples to the laboratory within a day, for processing using relatively sophisticated and expensive techniques (Michel, Müller and van Helden, 2010; de la Rua-Domenech, 2006).

Several other tests have been developed to improve diagnosis and screening of bovine tuberculosis

Studies have compared the sensitivity and specificity of the tuberculin skin test and the interferon gamma assay (Whipple *et al.,* 1995; Wood *et al.,* 1991). These studies showed that for both tests results may differ depending on the conditions in which the test is performed, the reagents used, the chosen cut-off point for the stage of development of the infection, the immune status of the animal, etc.

Identification of bovine tuberculosis by meat inspection at slaughterhouses is another important surveillance instrument, although its sensitivity is rather low. Depending on the prevalence of the disease in the country, abattoir surveillance can be used as a cost-efficient method alone or combined with routine cattle testing. However, this assumes reliable inspection practices at slaughter, supported by an efficient animal identification system and adequate record-keeping at both the farmer and the slaughterhouse levels.

Test and slaughter

Most of the countries that have eradicated or markedly reduced the prevalence of bovine tuberculosis in cattle have done so through effective implementation of a test-and-slaughter policy. Herds are tested using the tuberculin skin test and reactors are immediately removed for slaughter. The herds are then retested after prescribed periods, until no further reactors are detected and there is no evidence of tubercules in reactors at slaughter.

The success of control programmes based on test-and-slaughter strategy depends on institutional and technical requirements, including:

- an efficient cattle identification system that allows effective trace-back to the herds of origin of tuberculous animals detected through slaughter-house surveillance;
- a high standard of meat inspection practices, enabling effective surveillance for tuberculous lesions in animals passing through slaughterhouses;
- an animal health information system for recording relevant information, including epidemiological investigations, and data analysis to monitor progress and guide decision-making;
- a legal framework for enforcing control measures and compensating farmers for slaughter of tuberculin-positive reactors;
- full control of movement of cattle, including cross-border transhumance;
- political support, with the cooperation of stakeholder groups and public awareness, to ensure the success of the bovine tuberculosis control and eradication programme;
- public awareness campaigns and sensitization of farmers and the general public on bovine tuberculosis hazards and hygiene practices, and awareness of the objectives, benefits, challenges and other implications of surveillance and control;
- incentives for farmers to adhere to the eradication programme, such as guaranteed milk prices and favourable subsidies for disease-free herds;
- financial resources for adequate and speedy compensation of farmers for losses due to removal of infected animals;
- laboratory diagnostic capability for tuberculosis diagnosis based on the isolation and species identification of the bacterium from tuberculous lesions on organs.

Treatment and vaccination

The treatment of tuberculosis-affected livestock with medications has had limited success and is forbidden in most countries, particularly because of the potential for increasing the drug resistance of Mycobacteria. A few rare animal species in captivity have been treated with medications, but this is not really a viable option for a herd of free-ranging animals (Michel *et al.,* 2006). At present, control or eradication by means of treatment is neither feasible nor permitted in most countries.

Currently, the only vaccine against *M. bovis* infection is bacille Calmette-Guerin (BCG), which is a live attenuated strain of *M. bovis*. Apart from the limited efficacy of BCG vaccine in cattle, it can also compromise the tuberculin skin testing of animals. BCG vaccination has been tested in wildlife through experimental and field trials with

promising results (Buddle *et al.,* 2011). However, so far, no practical or effective vaccination approaches have been developed for any species. With advanced research on the genome sequences of *M. bovis* and the BCG vaccine, and the development of other types of vaccines such as subunit vaccines (in the form of desoxyribonucleic acid [DNA] vaccines) or adjuvated protein subunit vaccines, along with improved understanding of the protective immune response, it may become feasible to design and develop effective mycobacterial vaccines and vaccination strategies for preventing or controlling bovine tuberculosis in cattle or wildlife (Buddle *et al.,* 2011)

Limitations to bovine tuberculosis surveillance and control in developing countries

In developing countries, bovine tuberculosis is still common, especially in the dairy sector. The upsurge in peri-urban dairy production, unregulated animal movement, lack of animal identification, lack of surveillance at slaughterhouses, and weak veterinary services all contribute significantly to the poor control of animal tuberculosis in these countries.

Although regular tuberculin skin testing and elimination of infected animals has been successful in eradicating or significantly reducing bovine tuberculosis from cattle herds in many developed countries, these control measures are not always affordable and may not be practical in many parts of the world. In some cases, the policy of test and slaughter is in place, but it is not always vigorously pursued, and positive reactor animals may not be effectively quarantined or culled. This is largely because of legal and economic constraints such as the high cost of sustainable testing and slaughter of infected animals, and the subsequent compensation to farmers. Results may therefore be the opposite of those intended, with the policy contributing to the spread of disease through the sale of reactors. It is likely that some countries need to adopt feasible strategies for progressive control of animal tuberculosis by introducing interim measures such as segregation and phased slaughter of reactors, while improving biosecurity on farms. Although this approach may reduce the economic loss for the farmer, its usefulness may be limited by the difficulty of managing the segregation of reactors.

Veterinarian training session at a farm

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Limited laboratory diagnostic capacity is one of the major constraints to bovine tuberculosis control programmes in many developing countries. Diagnosis of tuberculosis is usually limited to microscopic evaluation of the microorganism on smears, making it difficult to confirm infected cases and identify the strains of *Mycobacterium* involved.

Post-mortem inspection at slaughterhouses is a cost-efficient method for passive surveillance of bovine tuberculosis. However, the quality of detection of tuberculous lesions in slaughterhouses can vary within the same country, with implications for the effectiveness of surveillance. In addition, routine post-mortem surveillance may not be possible if slaughtering facilities are limited. For instance, in many African countries there are few abattoirs, and more than 50 percent of slaughters take place informally, with no meat inspection (Michel *et al.,* 2004). When abattoir surveil-

lance data do exist, they are not always integrated into the national official notification system, and so are not used effectively.

Insufficient collaboration at the regional level, lack of quarantine and border security, and illegal movement across borders between neighbouring countries have also been identified as factors contributing to the persistence of bovine tuberculosis and undermining control efforts in several developing countries.

Rural communities in many developing countries are not aware of the risk factors associated with the transmission of bovine tuberculosis, and living conditions often promote the spread of *M. bovis* infection in humans. In these situations, the risk of zoonotic transmission should be addressed through education and prevention programmes to inform cattle owners about the risks of bovine tuberculosis and the necessity for pasteurizing milk and inspecting carcasses after slaughter.

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Farmer milking a cow, Bangladesh

Conclusions

Bovine tuberculosis remains of great concern worldwide. In developed countries, significant progress has been made in controlling and eradicating the disease in cattle, primarily via test-and-slaughter strategies, and in humans via improved hygiene practices for and pasteurization of milk. However, eradication programmes in some countries are constrained by the presence of endemic infection in wildlife reservoir hosts. Multisectoral research efforts seek to improve understanding of the role of wildlife host reservoirs in the dynamics of *M. bovis* infection in cattle and to develop sustainable control strategies using a variety of tools and measures targeting both cattle and wildlife. Many authors support the introduction of control options that include the development of appropriate vaccines and their deployment in vaccinating wildlife where test-and-slaughter programmes have failed. Improved testing tools and additional research on *M. bovis* are also needed.

In developing countries, the disease continues to cause significant losses in the cattle industry, with implications for food security and trade. In the absence of effective surveillance and control strategies, bovine tuberculosis continues to be a major public health problem, especially in countries where the prevalence of infection in cattle is high, consumption of raw milk products is common, and malnutrition and other immunosuppressive conditions exacerbate the danger of the infection. The impact of bovine tuberculosis on public health is likely to worsen given the potential increase in drug resistance of *M. bovis* in situations where human infections are not effectively treated. There are still critical gaps in understanding of disease patterns, the real extent of the disease in cattle and other animals, and the strains involved. Better surveillance of bovine tuberculosis is required in many countries, through improved post-mortem inspection, efficient tracing of infected animals to their herds of origin, regular tuberculin skin testing, and effective laboratory diagnostic support. There is also need for qualified veterinary staff at slaughterhouses to ensure adequate meat inspection practices and standards. Effective implementation of these activities would allow countries

to generate quality data and acquire sufficient knowledge of the epidemiology of the disease for developing strategic, cost-efficient and effective control programmes. From successful experiences in many developed countries, it can be concluded that bovine tuberculosis can be controlled only when there is strong political and producer support, an appropriate legal framework to enforce control measures, and active participation of all concerned in finding practical and affordable control options that are suitable for each country and each epidemiological context. Eradication is a more difficult target and requires many factors to be in place, including the necessary financial resources.

Tuberculosis due to *M. bovis* has a complex epidemiological pattern, which includes the transmission of infection within and among humans, domestic animals and wildlife. Control and eradication of bovine tuberculosis provides an ideal platform for the One Health approach, which can be operationalized through adapted approaches for improving surveillance and meat inspection, promoting milk pasteurization at the community level, and strengthening intersectoral collaboration. FAO is working in this direction by developing and implementing a One Health approach for comprehensive and integrated control of animal diseases that have impacts on public health, food security and human livelihoods

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Foot-and-mouth disease

Foot-and-mouth disease in Egypt, Libya and the Gaza Strip: crisis and response

Background

Foot-and-mouth disease (FMD) has been present in Egypt for decades, with serotypes O and A detected regularly. In 2006, an incursion of an exotic type A virus (A/Africa/G-VII) from sub-Saharan Africa was detected. This virus caused a serious epidemic (Sumption, 2006; Knowles *et al.,* 2007), spreading rapidly throughout the livestock population and circulating until at least 2009. In Libya, FMD has been reported sporadically, with type O FMD virus (FMDV) reported in 1994 and a SAT2 virus detected in 2003 (Knowles, 2012). The Gaza Strip has also periodically experienced FMD outbreaks, with type O FMD reported in recent years.

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Severe FMD lesions on the tongue

Following the political turmoil in Egypt and Libya in 2011, patterns of livestock movement in the border regions between southern Egypt and Libya and sub-Saharan Africa have changed. The relatively higher price of meat in Libya, compared with surrounding areas, has also stimulated the flow of animals into Libya, potentially spreading transboundary animal diseases. Border security has been compromised on the borders of Libya with Chad, the Niger and Algeria, increasing the risk of new diseases being introduced.

SAT2 detected in Egypt and Libya

In response to the type A epidemic, the European Commission for the Control of Foot-and-Mouth Disease (EuFMD) provided the Government of Egypt with assistance in strengthening FMD surveillance and control capacity in Egypt from 2008 to 2012, initially through an emergency Technical Cooperation Programme (TCP) project, and later with funding and technical support. In February 2012, the Egyptian authorities noticed a marked increase in cases of FMD compared with previous months, and brought this to the attention of national and international FMD experts on 29 February 2012 at a workshop of the Food and Agriculture Organization of the United Nations (FAO)/EuFMD project in Cairo (Egypt). Egypt's Animal Health Research Institute (AHRI) confirmed SAT2 as the causative virus in early March; results were subsequently confirmed by the FAO/World Organisation for Animal Health (OIE) FMD World Reference Laboratory (WRL) in Pirbright, United Kingdom of Great Britain and Northern Ireland.

Shortly afterwards, the WRL detected SAT2 in samples taken in February 2012 from a suspected FMD outbreak near Benghazi, Libya (Lockhart *et al.,* 2012). Type O FMDV was also detected in samples taken in February 2012 near Tripoli, Libya.

Genetic analysis of the Egyptian and Libyan SAT2 isolates showed that although the viruses belonged to the same topotype (VII), they were of three distinct sublineages (one Libyan and two Egyptian) and could therefore represent three separate, unrelated incursions (Knowles, 2012).

In addition to the SAT2 incursions, an exotic type A virus from sub-Saharan Africa was detected in Egypt in February. Genetic analysis showed that it belonged to the A/Africa/G-IV sublineage and was not related to the type A virus (A/Africa/G-VII) detected in Egypt from 2006 to 2009.

These findings indicated a serious situation, with four different incursions of FMD viruses from sub-Saharan Africa into northern African countries detected in one month (SAT2 into Libya; two separate SAT2 viruses and a type A virus into Egypt).

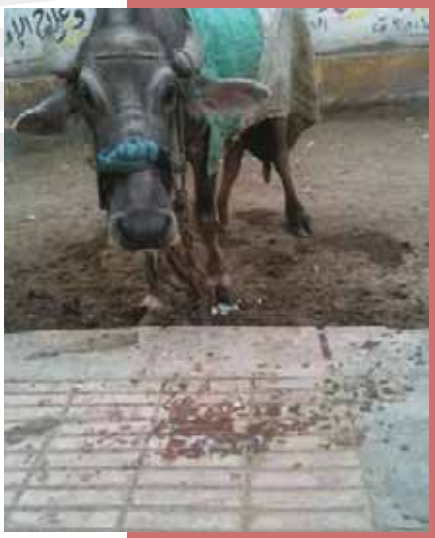
The initial FAO/EuFMD response

FAO and EuFMD were involved in confirming SAT2 and the immediate response. An EuFMD rapid assessment mission was deployed to Egypt on 12 March 2012 at the request of the Egyptian government. To assess the situation, the mission first carried out field visits to infected farms in Gharbiya Governorate in the Nile Delta, visited AHRI and met staff from the General Organization for Veterinary Services (GOVS). In collaboration with FAO's Emergency Centre for Transboundary Animal Disease Operations (ECTAD) in Cairo, the mission team made a series of preliminary recommendations for immediate actions to address the spread of SAT2. This initial work was followed by ongoing support missions approximately every two weeks, which have continued to provide additional direct support and advice to the Egyptian authorities.

On 21 March, Dr Lubroth, Chief Veterinary Officer (CVO) of FAO requested that the Crisis Management Centre–Animal Health (CMC-AH) facilitate FAO's actions and use its emergency response processes to coordinate a more extensive and complex response. A Strategic Planning Group was established to develop a prioritized joint strategy and lead FAO/EuFMD's response to the threat. The prime need was to complete a risk assessment on the spread of FMD serotype SAT2 in the region, to provide the basis for further development of the strategy.

FAO organized discussions – held on 27 March 2012 in Istanbul, Turkey – for animal health personnel from Egypt and from areas at high risk of the introduction of SAT2, because a regional approach to addressing this threat was needed. CMC-AH presented principles for good emergency management (FAO, 2011) and offered assistance in the further development of animal disease emergency preparedness and response plans.

EuFMD organized a training course on laboratory diagnosis of FMD in Cairo, which was attended by laboratory staff from Egypt, Libya, the Gaza Strip and the West Bank. EuFMD provided participants with antigen detection enzyme-linked immunosorbent assay (ELISA) kits (manufactured by the *Istituto Zooprofilattico Sperimentale della Lombardia e dell'Emilia Romagna* [IZSLER], Brescia, Italy), to facilitate rapid detection of disease in any samples submitted to the laboratories.



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Profuse salivation from an infected animal contaminating the yard of a veterinary clinic

Spread of the disease

During March and April, SAT2 FMD spread widely throughout Egypt. The clinical signs were reported to be more severe than had been seen with types O and A FMD

in Egypt, particularly in buffaloes. Significant mortality was reported in calves, causing severe losses and affecting food security.

In March, the Egyptian authorities reported more than 60 000 clinically affected large ruminants (cattle and buffaloes) with more than 14 000 fatalities due to suspected FMD. In April, the figures reported were approximately 19 000 clinically affected animals with more than 8 000 fatalities. Nationally, 205 of 280 districts had reported outbreaks by the end of March. By the end of April, 72 districts had not reported any clinical FMD, while 47 were still reporting outbreaks.

On 12 April 2012, a suspected case of FMD was reported on a farm near Rafah in the Gaza Strip. This was subsequently identified as SAT2 FMD virus by the Kimron Institute, Israel, and confirmed by the WRL. Genetic analysis showed that the Gaza Strip virus was identical to an Egyptian SAT2 virus, indicating a possible epidemiological connection between the two outbreaks.

A serious epidemic of FMD has been threatening the livestock population in Libya since the beginning of 2012, with different serotypes spreading in the western and eastern regions of the country. The first FMD notification of SAT2 came from the Benghazi area on 27 February 2012. Serotype O was reported from areas close to Tripoli and Benghazi in February, March and April 2012. The possibility of serotype A also circulating must be considered.

Control measures and vaccination

FAO and EuFMD assisted in the procurement of vaccine against SAT2 for the affected countries. Vaccine banks had lower stocks of antigen for SAT2 than for types A and O viruses. Israel initiated a vaccination campaign against SAT2 along its borders with Egypt and the Gaza Strip. Veterinary services in the Gaza Strip, supported by funds provided by the Canadian government, conducted a vaccination campaign against SAT2 in livestock.

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Infected animal in close contact with a susceptible animal at a veterinary clinic

Egypt initiated production of SAT2 homologous vaccines using two local vaccine manufacturers, and started a vaccination campaign in late April, targeting areas with few or no reports of FMD.

Extensive information campaigns for livestock keepers were conducted in Egypt with EuFMD/FAO technical assistance. These campaigns warned farmers of the dangers of disease spread, the importance of basic biosecurity measures and the benefits of vaccination.

Further support provided by EuFMD/FAO

CMC-AH deployed missions to Libya on 1 May 2012, and to the Gaza Strip and the West Bank on 14 May 2012. The objectives were to assess the situation, collect/submit additional samples for laboratory testing, advise the authorities and draw up action plans to assist in FMD control.

On 2 May 2012, FAO organized a workshop on FMD control in Cairo, where stakeholders, the authorities, FAO and EuFMD discussed and debated strategy responses and future actions for Egypt.

To build the necessary laboratory capacity, EuFMD supported a FMD laboratory training course, hosted and run in Paris, France by the *Agence nationale de sécurité sanitaire*, at which laboratory staff from Algeria, Chad, Lebanon, Mauritania, Morocco, the Niger and Tunisia were trained in FMDV diagnosis with particular emphasis on SAT2. To facilitate rapid laboratory diagnosis of FMD, each trainee was supplied with antigen detection ELISA kits for SAT1, SAT2, and A and O FMDV.

Since the SAT2 crisis began, EuFMD has supplied similar antigen detection ELISA kits to Ghana, Iraq, Israel, Jordan and Turkey, and plans to provide kits to the Syrian Arab Republic.

Further FAO/EuFMD support is planned in the form of technical guidance on disease surveillance and vaccination strategies, and training on epidemiology, detection of disease, surveillance and post-vaccination monitoring. As appropriate, CMC-AH missions will be followed up, and diagnostic supplies provided.

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Cattle market, Tripoli, Libya

Threat of further spread

The current FMD situation in northern Africa and the Near East is critical. A coordinated regional response is required to prevent spread of the disease and to assist affected countries in reducing the impact of FMD. SAT2 poses a threat to countries to both the east (particularly Israel, Jordan, the West Bank and neighbours) and the west (Algeria, Morocco and Tunisia) of Egypt and Libya. The risk of further sub-Saharan FMD viruses being introduced is still present, and continual assessment of this risk, including heightened surveillance and pathway analysis, is needed to help identify methods for preventing future incursions into northern Africa and the Near East.

Summary

Since February 2012, a severe SAT2 epidemic has spread through Egypt and into the Gaza Strip. A separate outbreak of SAT2 has been detected in Libya. Type O viruses are also circulating in Libya. Types O and A FMD viruses have been detected in Egypt. FAO and EuFMD have developed a regional strategic plan for containing SAT2, with the aim of containing spread to neighbouring countries and reducing the impact in affected areas. Implementation of this strategic plan has begun, with a focus on preventing spread to neighbouring regions. A regional response is required for the medium and long terms, to prevent the disease from causing further damage to livestock, livelihoods and food security.

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Schmallenberg virus: a new virus threatening livestock farming in Europe

Overview of the Schmallenberg virus outbreak in Europe

In mid-December 2011, a novel vector-borne orthobunyavirus, the Schmallenberg virus (SBV), was identified in Europe. As of 1 June 2012 it had been implicated in 3 745 officially reported events of congenital malformations[1] and stillbirths of sheep, goats and cattle in western European holdings in eight countries. The maximum proportions of sheep holdings reported as having SBV confirmed were 4 percent at the country level and 7.6 percent regionally; fewer than 1.3 percent of cattle holdings were reported as SBV confirmed at either the country or the regional level.[2] Figure 1 demonstrates the SBV epidemiologic curve by species. The first isolation of the virus was from a cow with diarrhoea, fever and decreased milk production on a farm in the town of Schmallenberg, Germany in August 2011. This was followed in September 2011 by reports of the same syndrome in cattle on farms in Germany and the Netherlands.[3] Typically the symptoms disappeared after several days. The initial acute disease was followed in December 2011 by an epidemic of stillbirths and congenital malformations, suggesting *in utero* infection of foetuses at different stages of gestation. As of 3 May 2012, cases of congenital malformations (Figure 2) and stillbirths attributed to this new virus continued to be reported in Belgium[4] (starting on 14 December 2011), France[5] (20 January 2012), Germany[6] (27 December 2011), Italy[7] (6 February 2012), Luxembourg[8] (7 February 2012), the Netherlands[9] (19 December 2011), Spain[10] (6 March 2012) and the United Kingdom of Great Britain and Northern Ireland[11] (14 January 2012). In Belgium and the Netherlands historical samples from cattle that had shown clinical signs of diarrhoea, fever and decreased milk production were taken in the autumn (August to October) of 2011 during the period of activity of *Culicoides* spp., and tested by quantitative real-time polymerase chain reaction (PCR). Three of 23 samples tested positive for SBV in Belgium and 25 of 50 samples in the Netherlands, indicating exposure of the livestock population at that time.[12]

The Schmallenberg virus was identified in western Europe in eight countries

Orthobunyaviruses are mainly transmitted by mosquitoes (*Culicidae* spp.) and midges (*Culicoides* spp.) and are found in a variety of livestock and wildlife reservoirs. Ex-

[1] The susceptible population is considered to be exposed pregnant ruminants. Suspect cases are considered to be cases of limb and brain defects, including arthrogryposis, shortening of the hamstrings, deformation of the jaw, hydranencephaly, stiff neck, or newborns with neurological disorders such as flaccid paralysis, blindness, exaggerated movements, hyperexcitability, hypoplasia of the cerebellum, feeding difficulties and ataxia. www.efsa.europa.eu/en/efsajournal/doc/2768.pdf

[2] *Ibid.*

[3] www.abvma.ca/biosecurity/documents/biosecurityinaction_emergenceofschmallenberg-virus.pdf

[4] www.coda-cerva.be

[5] http://agriculture.gouv.fr/virus-schmallenberg-bruno-le-maire

[6] www.fli.bund.de/en/startseite/current-news/animal-disease-situation/new-orthobunyavirus-detected-in-cattle-in-germany.html

[7] http://web.oie.int/wahis/public.php?page=single_report&pop=1&reportid=11660

[8] http://web.oie.int/wahis/public.php?page=single_report&pop=1&reportid=11664

[9] www.vwa.nl/onderwerpen/dierziekten/dossier/schmallenbergvirus

[10] http://web.oie.int/wahis/public.php?page=single_report&pop=1&reportid=11740

[11] www.defra.gov.uk/ahvla/2012/02/07/feb-schmallenberg-virus-further-uk-testing-results/

[12] www.cvi.wur.nl/nl/nieuwsagenda/nieuws/prevalentiesbvinnl.htm

Figure 1: Map of SBV distribution (observed from 14 December 2011 to 1 June 2012)

Sources: OIE WAHIS and national authorities, as recorded in EMPRES-i.

amples of other orthobunyaviruses causing disease in livestock are Akabane virus and Rift valley fever virus (a zoonosis). SBV has now been identified in *Culicoides obsoletus* and *C. dewulfi*, from pools of midges collected in September and October 2011.[13] The investigating laboratories conducted quantitative real-time PCR on the heads of the midges (avoiding their recent blood meals), and positive results suggested that the virus was present in the salivary glands, indicative of active vector transmission.[14]

According to an initial risk assessment conducted by the European Centre for Disease Prevention and Control (December 2011)[15] and two recent 2012 field studies conducted in Germany[16] and the Netherlands,[17] there is no evidence of zoonotic infection.

Important questions to be answered relate to the duration of viraemia in naturally infected animals and the range of susceptible species; the other routes of transmission and the epidemiological role of trans-placental transmission; the risk factors, such as exposure to vectors or gestation period at the time of infection; and the interpretation of serological tests (currently the virus neutralization and the indirect immune-fluorescence tests) in the epidemiological context. These and other technical issues need to be clarified before the full implications of SBV for trade in animals and animal products can be understood. Serological tools are currently available for large-scale surveys,[18] and these can be used to demonstrate whether the agent is established in a

[13] www.promedmail.org/direct.php?id=20120311.1066949
[14] www.defra.gov.uk/animal-diseases/files/poa-schmallenberg-update-120311.pdf and www.coda-cerva.be/images/pdf/promed%20sbv%20europe%2026.pdf
[15] http://ecdc.europa.eu/en/publications/publications/231112_ter_risk_assessment_schmallenberg_virus.pdf
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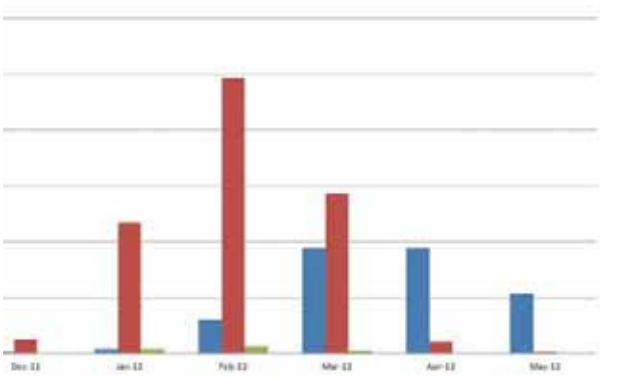
[17] www.geostrategicforecasting.com/proah-schmallenberg-virus-4/
[18] http://ec.europa.eu/food/animal/diseases/schmallenberg_virus/docs/diagnostic_tools_en.pdf

Figure 2: SBV cases occurring from 14 December 2011 to 1 June 2012, by species



Sources: OIE WAHIS and national authorities, as recorded in EMPRES-i.

much larger geographical area than currently recognized. It is possible that the disease is not recognized because it is being confused with other similar syndromes.

Conclusions

The Food and Agriculture Organization of the United Nations (FAO), the World Organisation for Animal Health (OIE) and the World Health Organization (WHO) are closely monitoring the situation of SBV in animals and the potential implications for animal and human health. The evidence to date indicates that there are no human cases associated with the animal cases in the countries affected.

For other regions around the world, the emergence of SBV in western Europe highlights the importance of increasing surveillance for mortality in lambs and malformation in newborn animals, particularly in areas with significant populations of ruminants and environmental conditions that are suitable for *Culicoides* spp. The geographical expansion of bluetongue from northern Africa to Europe a few years ago indicates the potential risk of SBV vectors moving from Europe to other regions, including northern Africa and eastern Europe, during next spring or summer.

Close collaboration between farmers and animal health services is necessary to ensure rapid detection of any unusual change in the health status of animals. The relatively quick recognition of a new pathogen in the ruminant populations of affected areas demonstrates the importance of effective passive surveillance systems that depend on good linkages between farmers and public and private animal health services.

Considering the large numbers of cattle and sheep establishments in affected countries, this has so far been a low-impact disease, based on the relatively low numbers of farms where virus has been identified in deformed newborn animals.[19]

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[19] www.defra.gov.uk/animal-diseases/files/poa-schmallenberg-update-120326.pdf

Peste des petits ruminants

Livelihood-centred animal health protection: the case of peste des petits ruminants and small ruminants

Protecting the livestock assets of smallholder farmers is vital to enhancing the food security and resilience of rural households, which are two important livelihood indicators. Reducing the animal disease burden within smallholder systems is one of the most effective ways of improving these indicators. However, over the past couple of years, a multitude of animal diseases that threaten household-level production units have emerged on the global scene. African swine fever (ASF) is spreading rapidly among pigs in the Caucasus and eastern and central Africa. Highly pathogenic avian influenza (HPAI) remains endemic among poultry in several countries, including Egypt and Viet Nam. Peste des petits ruminants (PPR) is endemic in large tracts of Asia and Africa, and is spreading to new countries and populations. Smallholder farmers may therefore have to deal with more than one disease simultaneously, with each disease alone having the ability to destroy the foundation of smallholder livelihoods. Smallholders do not usually have the resources to invest in animal health unless they can increase their animals' productivity. It is therefore essential that approaches to managing and controlling these diseases at the smallholder level seek to include livelihood and production strategies. This note argues for a livelihood-centred approach to disease control at the smallholder level.

Goats and sheep being cared for in Bichi, northern Nigeria

There are compelling reasons for selecting PPR as the first target when developing a livelihood-centred approach to animal health protection:

- Lessons learned from rinderpest eradication are of immediate relevance to the control of PPR, including the importance of understanding the disease epidemiology, the context of the farming systems affected, and the disease control delivery mechanisms used.
- A suitable and effective vaccine that transfers life-long immunity already exists.
- Diagnostic tests exist, although they are not widely used.
- There are "win–win" possibilities for integrating PPR control with other strategic animal health interventions in small ruminant production.
- The international community is increasingly interested in supporting resource-poor communities by providing access to extension services and veterinary care, and by combating diseases that affect the livestock of the poor (such as PPR).

One of the major challenges to PPR control arises from the characteristics of small ruminant production. A wide range of production systems benefit from the adaptability and economic role of small ruminants as their most important asset. Small ruminants are often found in geographically, socially or economically marginalized communities, and/or are produced by people with limited access to services. Most goats and sheep are kept in extensive pastoralist and agropastoralist systems, partly

because these animals can adapt to the harsh conditions that often exist in poorly accessible or remote landscapes. Most of the people involved in small ruminant production operate mixed farming systems in which there are clear synergies between crop and small ruminant production: crop residues provide animal feed, while manure improves soil fertility. Small ruminants can also be found in diverse peri-urban and urban agricultural systems. Women in many parts of the world depend on sheep and goat production to feed and educate their families.

At the national level, the absence of effective representation for small ruminant producers limits their access to policy-makers and resources, which helps to explain the lack of attention to PPR. Veterinary services are challenged by the short cycle of small ruminant production, which reduces the benefit-to-cost ratios of investments in animal health. Some animal health inputs have to be more frequent (e.g., vaccinations) and the costs have a shorter period over which to be earned back. It is therefore essential for any PPR animal health strategy to engage small ruminant owners in improving their own systems through production-enhancing interventions that increase the value of investments in PPR control; and to improve small ruminant owners' access to local delivery mechanisms for animal health services.

The three pillars of a livelihood-centred approach to animal health protection

A livelihood-centred approach to PPR control is essential because it is adapted to the wide range of small ruminant production and PPR disease scenarios that result from the heterogeneous socio-ecological and climatic characteristics of the production systems and their extensive nature. The three main pillars of such an approach are:

- increased production at the household level through reduced disease burden, to empower and improve the resilience of smallholders and encourage investments in animal health;
- community engagement, to ensure that strategies and animal health delivery mechanisms are appropriate to local needs;
- national and international support, through policy support and initial investments in technology development, which are justified by the strong public good character of reducing poverty and enhancing food security.

To support the three pillars, the livelihood-centred approach to protecting animal health through PPR control seeks complementarities between:

- veterinary technological advances in PPR diagnostics and vaccine and local understanding of disease dynamics;
- existing tools and novel delivery mechanisms, such as farmer field schools and community herd health;
- the needs of men and women producers of small ruminants, enhancing productivity, increasing their household and community resilience, and boosting their off-take.

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Goats and sheep being cared for in Bichi, northern Nigeria

A livelihood-centred approach presents major opportunities for upgrading production, which will in turn empower communities to invest in their own animal health care. Attention will therefore also need to be given to other diseases that curtail production, such as brucellosis, sheep and goat pox, contagious caprine pleuropneumonia (CCPP) and ecto- and endoparasites. Increased production through reduced disease burden will require an improved market position for small ruminant owners, which in turn depends on improving value chains and enhancing understanding of them, including the roles and dependences of other stakeholders. The international community will have to invest resources and time in developing understanding of the interrelations among farming systems, the epidemiology of PPR and the impact of other diseases. These investments are fully justified by the potential positive effects on food security and poverty reduction through reduced mortality. Animal health delivery mechanisms will need to be developed and modified according to the various farming systems and demands of smallholders. The scope of this approach therefore moves beyond PPR control, to address increased income and human nutrition, gender equity, improved risk mitigation, better small ruminant husbandry and management, value chain development, and rural livelihood protection.

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Goats and sheep being cared for in Bichi, northern Nigeria

A fundamental premise to such an approach is that it builds on what already exists, and develops local service providers' understanding of how to target interventions at the local level, so as to provide rational animal health decision-making and resources when and where needed. It may be necessary to develop different forms and protocols of engagement between farmers and service delivery agents, and to involve a broad array of development partners and disciplines so that overall engagement is led by individuals and agencies with experience in positioning livelihoods at the centre of an animal health strategy.

The initial steps are:

- identifying and targeting technical and social interventions for small ruminant keepers in diverse settings and along the value chain, to enhance productivity, improve livelihoods and increase smallholders' abilities to deal with risk – including by developing and delivering new and existing technologies and providing access to effective, quality assured, thermo-stable PPR vaccine, with bi-/trivalent options where appropriate;
- assessing the linkages between PPR and farming systems, and the options for animal health delivery mechanisms that are adapted to livelihood strategies and needs;
- establishing medium- to long-term engagement protocols for all the main partners in the development process, including clear policy guidelines on the role of para-veterinarians and linkages to the private sector.

FAO is seeking international support for this novel livelihood-centred approach to the control of one of the most important animal diseases affecting the poor.

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Profiling laboratory capacity in the context of emerging pandemic threats: the FAO Laboratory Mapping Tool

The ability of diagnostic laboratories to detect and characterize infectious agents, and therefore to support the prevention and management of health threats, is frequently obstructed by – among other factors – the lack of resources such as skilled personnel, accurate and consistent laboratory methods and quick data exchange systems (CDC, 2010). Cooperation and collaboration among laboratories has long been recognized by public health experts as key to enhancing the gathering, detection, reporting and analysis of information regarding infections and outbreaks (Beebe, 2006). Deficiencies in the capacities and capabilities of laboratories may lead to inadequate responses to disease emergencies at the animal–human interface.

As part of efforts to address these deficiencies, the Food and Agriculture Organization of the United Nations (FAO) has developed the FAO Laboratory Mapping Tool to aid laboratory assessment. This tool is used in collaboration with national partners to determine gaps in laboratory functionality and define mechanisms and targets for capacity building to fill these gaps (Box 1). The tool allows the generation of a laboratory profile or "map", and can be adapted to demonstrate functionality and capacity status at the national, regional and global levels. It can also be used to establish a baseline for laboratory status (at the single laboratory, national or regional level) prior to an intervention; progress and impact can be measured against this baseline during and after the intervention (FAO, 2010).

Box 1: Importance of laboratory mapping

Laboratory mapping is an essential basis for:

- generating reliable and accurate data to support the development of strong animal disease prevention and control systems by indicating the overall functionality of a laboratory;
- generating a picture of laboratory functionality within and across regions, thus underpinning regional and global approaches to laboratory strengthening;
- analysing needs by providing an indication of the actions required to update and improve the functionality of individual laboratories or of all the laboratories within a region;
- helping laboratories to assess their own functionality and identify priorities and gaps through comparisons with good practice scenarios;
- providing a baseline against which objectives can be set and progress monitored over time;
- enabling development partners to recognize laboratory functionality and take appropriate and sustainable measures to support the improvement of laboratory capacities.

Using the FAO Laboratory Mapping Tool

The FAO Laboratory Mapping Tool is based on a standardized format that allows data to be captured either by external evaluators or through self-assessment. The tool is designed to facilitate the assessment of laboratory functionality[1] in a systematic and semi-quantitative manner. Initially, two slightly different versions were developed and piloted in three regions (South and Southeast Asia and the Congo Basin in Africa). Feedback was collected for improving the tool (Box 2), and the two versions were harmonized into a single tool that can be used in any region to generate knowledge of laboratory functionality across regions, particularly regarding investment needs and risk modelling of disease emergence and spread.

Box 2: Pilot use and preliminary results of the FAO Laboratory Mapping Tool under the IDENTIFY project

Combating emerging zoonotic diseases at their source is the objective of the United States Agency for International Development's (USAID's) Emerging Pandemic Threats (EPT) programme. FAO, the World Organisation for Animal Health (OIE) and the World Health Organization (WHO) implement the IDENTIFY component of the EPT programme, which seeks to strengthen national laboratory capacity for rapid, accurate and sustainable detection of targeted diseases in the areas that USAID defines as having the highest risk of emerging human and/or animal diseases. These hot-spot areas are the Congo Basin in Central Africa and countries in South and Southeast Asia.

The FAO Laboratory Mapping Tool was applied in years 1 and 2 of the IDENTIFY project in the three regions, at 12 laboratories in 11 countries in the Congo Basin – Botswana, Cameroon, the Central Africa Republic, Congo, the Democratic Republic of the Congo, Ethiopia, Gabon, Nigeria, Rwanda, Senegal, Uganda and the United Republic of Tanzania; 11 laboratories in nine countries in Southeast Asia – Cambodia, China, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, the Philippines, Thailand and Viet Nam; and three laboratories in two countries in South Asia – Bangladesh and Nepal. External assessors first applied the tool to generate baseline information for categorizing the laboratories in the project and to map national and regional strengths and weaknesses.

The functionality of the 26 laboratories analysed was categorized as basic for five, moderate for 15, and advanced for six (Figures 1 and 2). The main constraints for most of the laboratories were: i) low operating budget from the national government; ii) prohibitive costs for equipment, maintenance and reagents; iii) difficulties in ensuring biosafety and biosecurity; iv) inadequate human resources in terms of skills and number; v) insufficient flow of samples to justify laboratory maintenance and operating costs; and vi) limited access to up-to-date information from scientific publications.

In year 3 of the project, the tool will be applied a second time in some laboratories in Southeast Asia and the Congo Basin to measure progress. All target laboratories have agreed to undergo this mapping exercise. Comparisons between the results of the tool and USAID/FAO monitoring and evaluation frameworks will give a clear picture of the project´s progress and impact on laboratory functionality.

[1] With particular focus on the capacity and capability to respond to regional priority diseases determined under the IDENTIFY project.

Figure 1: Level of advancement of national veterinary laboratories in the Congo Basin

Category	*1	*2	*3	*4	5	6	7	8	9	10	11	12
Geographic location	100.0	88.9	66.7	77.8	88.9	66.7	66.7	88.9	88.9	55.6	44.4	55.6
Laboratory budget	77.8	77.8	66.7	44.4	44.4	22.2	33.3	22.2	22.2	11.1	11.1	0.0
Basic supply	100.0	100.0	88.9	66.7	100.0	77.8	100.0	88.9	88.9	55.6	55.6	44.4
Organization	100.0	100.0	66.7	66.7	66.7	66.7	100.0	66.7	66.7	66.7	66.7	66.7
Linkage with satellite labs	100.0	55.6	100.0	100.0	100.0	55.6	33.3	66.7	100.0	55.6	55.6	55.6
Communication means	75.0	66.7	83.3	66.7	66.7	50.0	50.0	41.7	66.7	41.7	50.0	25.0
Infrastructure	54.2	70.8	50.0	45.8	45.8	45.8	54.2	41.7	37.5	33.3	20.8	12.5
Equipment	44.4	61.1	44.4	38.9	27.8	27.8	44.4	27.8	38.9	22.2	22.2	22.2
Reagent supply	79.2	70.8	58.3	58.3	58.3	58.3	58.3	41.7	37.5	29.2	29.2	29.2
Staff skills and availability	79.2	91.7	95.8	91.7	87.5	87.5	95.8	79.2	70.8	41.7	33.3	25.0
Sample accession	66.7	72.2	44.4	38.9	50.0	38.9	38.9	50.0	44.4	33.3	27.8	22.2
Available technology	59.3	66.7	66.7	55.6	63.0	55.6	48.1	55.6	33.3	14.8	14.8	14.8
Training	55.6	88.9	55.6	55.6	55.6	55.6	55.6	55.6	55.6	55.6	55.6	55.6
Quality assurance	95.8	100.0	75.0	75.0	79.2	75.0	66.7	79.2	62.5	66.7	66.7	66.7
Biosafety/biosecurity	38.9	66.7	50.0	50.0	50.0	50.0	38.9	44.4	38.9	44.4	44.4	44.4
Staff security/health	66.7	55.6	33.3	22.2	55.6	33.3	22.2	55.6	44.4	22.2	22.2	22.2
Laboratory collaboration	60.0	93.3	93.3	93.3	93.3	93.3	73.3	86.7	73.3	46.7	46.7	46.7
Use of databases/platforms	41.7	75.0	66.7	66.7	58.3	58.3	58.3	41.7	41.7	25.0	25.0	25.0
Total	68.4	77.3	66.0	61.3	64.2	57.4	57.1	56.4	52.5	38.3	36.2	33.0

Figure 2: Level of advancement of national veterinary laboratories in South and Southeast Asia

Category	*1	*2	3	*4	5	6	7	8	9	10	11	12	13	14
Geographic location	66.7	77.8	88.9	66.7	88.9	44.4	55.6	22.2	55.6	55.6	22.2	88.9	66.7	11.1
Laboratory budget	77.8	77.8	66.7	66.7	55.6	66.7	33.3	55.6	55.6	44.4	44.4	0.0	0.0	11.1
Basic supply	100.0	100.0	88.9	100.0	100.0	100.0	33.3	44.4	66.7	44.4	77.8	44.4	44.4	11.1
Organization	100.0	100.0	100.0	66.7	66.7	66.7	66.7	66.7	66.7	66.7	66.7	66.7	66.7	66.7
Linkage with satellite labs	100.0	100.0	88.9	77.8	44.4	66.7	66.7	66.7	0.0	66.7	33.3	55.6	33.3	44.4
Communication means	91.7	91.7	100.0	66.7	58.3	75.0	16.7	50.0	75.0	66.7	58.3	33.3	16.7	25.0
Infrastructure	91.7	87.5	75.0	75.0	70.8	41.7	25.0	54.2	50.0	45.8	41.7	37.5	41.7	25.0
Equipment	94.4	77.8	72.2	50.0	66.7	50.0	50.0	50.0	50.0	44.4	50.0	50.0	33.3	33.3
Reagent supply	87.5	83.3	83.3	75.0	62.5	62.5	29.2	66.7	62.5	25.0	41.7	16.7	20.8	4.2
Staff skills and availability	95.8	91.7	83.3	54.2	83.3	54.2	58.3	45.8	54.2	58.3	8.3	37.5	45.8	25.0
Sample accession	94.4	94.4	100.0	61.1	94.4	44.4	66.7	50.0	50.0	61.1	44.4	27.8	38.9	27.8
Available technology	96.3	96.3	88.9	63.0	59.3	66.7	59.3	63.0	70.4	18.5	14.8	18.5	11.1	11.1
Training	77.8	66.7	83.3	33.3	61.1	27.8	55.6	27.8	38.9	22.2	11.1	27.8	27.8	22.2
Quality assurance	79.2	95.8	79.2	58.3	33.3	41.7	66.7	58.3	29.2	37.5	8.3	20.8	20.8	16.7
Biosafety/biosecurity	83.3	72.2	100.0	72.2	66.7	61.1	55.6	33.3	44.4	22.2	50.0	16.7	11.1	5.6
Staff security/health	88.9	88.9	100.0	77.8	66.7	11.1	44.4	22.2	11.1	22.2	11.1	0.0	0.0	11.1
Laboratory collaboration	86.7	93.3	60.0	86.7	73.3	60.0	73.3	66.7	46.7	66.7	20.0	40.0	40.0	33.3
Use of databases/platforms	83.3	66.7	66.7	83.3	91.7	25.0	91.7	83.3	50.0	25.0	41.7	25.0	25.0	25.0
Total	88.7	86.5	83.7	66.3	67.7	52.5	52.1	52.1	49.6	41.1	31.9	30.5	28.4	20.2

Numbers represent the percentages achieved compared with the optimum situation of 100 percent. Red = basic diagnostic capacity (0 to 33 percent); yellow = routine diagnostic capacity (34 to 66 percent); and green = advanced diagnostic capability (67 to 100 percent).

* = regional service laboratory.

The most recent harmonized version of the FAO Laboratory Mapping Tool comprises five modules (Table 1): i) general laboratory profile; ii) infrastructure, equipment and supplies; iii) laboratory performance; iv) quality assurance and biosafety/biosecurity; and v) laboratory collaboration and networking. Within these five modules, 18 categories and 95 subcategories have been selected. These elements are thought to be fundamental for optimal laboratory functionality in ensuring laboratories' (in-)ability to receive samples, to diagnose/detect and report on animal diseases, and hence to detect emerging disease threats appropriately. For each subcategory, one of four options can be selected corresponding to scores from 0 to 3. A detailed questionnaire is used to collect data (95 scores of 0 to 3 each), and an overall score for the laboratory and summary scores for each of the categories are generated. The overall score is used to assign one of three levels of functionality to the laboratory: basic, moderate or advanced.

As the degree to which categories contribute to the overall functionality of a veterinary laboratory varies, the need to adopt a weighting system during calculation of a laboratory score was evaluated. A survey was conducted to gather the opinions of 21 laboratory experts from Africa, the Americas, Asia, the Balkans and the rest of Europe.

Table 1: Modules and categories for designing the Laboratory Mapping Tool questionnaire

Module	Category[1]	Main information captured	Number of subcategories
Module 1: General laboratory profile	Geographic location[a]	Strategic placing, location, accessibility	3
	Laboratory budget[c]	Financial autonomy	3
	Basic supply[c]	Electricity, water supply	3
	Organization[b]	Sustainable personnel organization system	1
	Linkage to satellite laboratories[b]	Exchange with satellite laboratories	3
	Communication means[b]	Functionality of communication means, access to publications	4
Module 2: Infrastructure, equipment and supplies	Infrastructure[c]	Containment, functionality, set-up for polymerase chain reaction (PCR) testing	8
	Equipment[c]	Equipment for disease (all agents) diagnosis, including post-mortem and molecular biological tools	6
	Reagent supply[c]	Fresh reagent supply, production, stocking, validity, procurement, affordability	8
Module 3: Laboratory performance	Staff skills and availability[c]	Number of trained and experienced staff, their expertise, effective working time, emergency service	8
	Sample accession[b]	Sample throughput, processing, reporting	6
	Available technology[b]	Pathology, virology, bacteriology, serology, molecular biology, animal experiment	9
Module 4: Quality assurance and biosafety/ biosecurity	Training[b]	External and internal training in laboratory performance, good laboratory practice, QA/quality control, maintenance, management, biosafety, sample shipment	7
	Quality assurance (QA)[c]	Standard requirements for competence to carry out tests and calibrations, best practice, standardization, internal and external QA testing, sample identification system	8
	Biosafety/biosecurity[b]	Biosafety/biosecurity application, unintentional release of pathogens from the laboratory	6
	Staff security/health[b]	Staff and environmental protection	3
Module 5: Laboratory networking	Laboratory collaboration[b]	In-country, regional, international, laboratory networking, twinning	5
	Use of databases/ platforms[a]	Information retrieval and sharing from public sources, use of e-platforms	4

[1] Experts' ranking: [a] = medium importance (rank 3); [b] = medium-high importance (rank 4); and [c] = high importance (rank 5).

Experts ranked each category on a scale of 1 (low importance) to 5 (high importance) according to the category's estimated impact on laboratory functionality. Analysis of the rankings for the 18 categories revealed three levels of importance: medium importance (median score 3); medium to high importance (median score 4); and high importance (median score 5) (Table 1). A weighting system based on these importance rankings was applied to the scores obtained from the Laboratory Mapping Tool, and the weighted and non-weighted scores were compared using Spearman's rank correlation coefficient test. There was no significant difference between the two scores ($p < 0.001$), so it was decided not to apply any weighting system for calculating the score for a laboratory.

The whole tool can be applied, or modules can be used separately (e.g., during onsite expert missions on quality assurance and biosafety). The tool and its modules can be applied by external and/or internal assessors to generate findings that are comparable over time. The tool also helps regional service laboratories to devise strategies for improving other laboratories within the network.

Conclusion and next steps

Application of the FAO Laboratory Mapping Tool in three regions facilitated standardized assessments of a large number of laboratories and the evaluation of strengths and weaknesses at the national and regional levels. Results will serve to measure progress and target needs for improvement, provide advocacy material, and inform decision-makers, donors, national bodies, etc. The tool will now be applied wherever possible and its use will be scaled up to other regions; it has been used in North Africa and South America. Countries may also use the tool to self-assess their own status. The FAO Laboratory Mapping Tool will be developed further to allow the application of individual modules to assess laboratory capacity for dealing with a particular disease or to measure the impact of a project on laboratory functionality.

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FAO Reference Centres

Background: the corporate policy for FAO Reference Centres

Over the course of its history, the Food and Agriculture Organization of the United Nations (FAO) has developed relationships with academic and research institutes, laboratories and other establishments to gather guidance, advice and specialized assistance in promoting agricultural issues related to food production, livelihoods, health and nutrition. Between 1957 and 1990, FAO's Animal Health Service (AGAH) established relationships with more than 50 institutions, which were referred to as "FAO reference laboratories and collaborating centres". In recent years, the designation of such centres has undergone an in-depth review, leading to the establishment of a corporate FAO policy in 2006, described in the Director-General's (DG) Bulletin 2006/32 (October 2006) for the designation of FAO Reference Centres. This designation is not bound to individual experts but is institution-based.

> "***FAO Reference Centres*** *are institutions designated by the Director-General to provide specific, independent technical/scientific advice on issues related to FAO's mandate."*

Following release of this new corporate policy, AGAH contacted all its reference laboratories and collaborating centres, informed them about the policy changes and invited them to apply for designation as FAO Reference Centres. Most institutes accepted this invitation and submitted applications. AGAH has also reviewed the technical areas covered by the former reference laboratories and collaborating centres and has identified missing technical and geographical areas. Gaps identified include expertise in risk analysis, wildlife, veterinary public health and laboratory biosafety, to provide policy advice, updated methodologies, goods and services to FAO members. As a result, AGAH is expanding the range of expertise in animal health provided by its Reference Centres, and the designation of new Reference Centres is an ongoing and dynamic process.

Reference Centres are expected to contribute to FAO strategic objectives and animal health activities by providing assistance in: i) preventing and detecting transboundary animal diseases, including zoonoses, and improving risk and disease management; ii) enhancing the understanding and analysis of factors that contribute to disease emergence, maintenance and spread; iii) supporting safer animal production, as part of economic development, food security, food safety and poverty alleviation efforts; iv) improving veterinary public health services; and v) guiding policies related to animal health.

Technical areas covered by FAO Reference Centres in animal health

AGAH has identified 18 technical areas for which Reference Centres are currently required (Table 1). Other areas will be identified as needs arise.

Table 1: Technical areas covered by Reference Centres

Specific diseases or groups of diseases:	Thematic areas:
Animal influenza and Newcastle disease	Veterinary epidemiology
Foot-and-mouth disease	Laboratory biosafety and biocontainment
Morbillivirus diseases	Vaccine quality control
Ruminant mycoplasma diseases	Wildlife health
Vector-borne diseases	Veterinary public health
Livestock parasitic diseases	Diseases at the human–animal interface
Brucellosis	
Tuberculosis and paratuberculosis	
African and classical swine fever	
Rabies	
Parasitic zoonotic diseases	
Viral zoonotic diseases	

Steps for the designation of a FAO Reference Centre

As outlined in the DG Bulletin, elaborated by AGAH and based on the corporate policy, the steps for designation as a FAO Reference Centre are:

- The institution submits an application and declaration of interest to AGAH.[1]
- The FAO technical unit (AGAH) evaluates the application, including the declaration of possible conflicts of interest.
- AGAH and the institution agree on a work plan.
- AGAH submits recommendations to higher FAO management for approval in principle.
- FAO consults government authorities in the country of the applying institution.
- The designation letter is drafted and shared with the applicant.
- On receipt of all clearance the final designation letter is sent to the institution for signature.

Areas of collaboration, the institution's mandate, annual reporting, and terms of use for the FAO logo are described in the designation letter, which is valid for four years.

Evaluation of applications

Technical panels are set up to evaluate applications against the main criteria laid down in DG Bulletin 2006/32:

- Ability to carry out one or several of the following functions:
  - standardization of technology, therapeutic and other substances, and methods/procedures;
  - provision of reference substances and services such as quality assurance;
  - participation in collaborative research of a scientific, technical or policy nature;
  - contribution to capacity development through the provision of training;
  - coordination of activities carried out by other institutions;
  - provision of information and advice of a scientific, technical and policy nature.
- Active engagement in fields of expertise relevant to the work of FAO, and contribution to the implementation of FAO's programme priorities and to strengthening capacities in countries and regions.

[1] At e-mail AGAH-Reference-Centre@fao.org.

- Prior successful collaboration with FAO for a minimum of two years (or less under special circumstances, to be justified and demonstrated by the relevant technical unit) in carrying out jointly planned activities.
- Submission of a declaration of interest.

Designation status

As at March 2012, seven institutions have been officially designated as FAO Reference Centres:

- For animal influenza and Newcastle disease:
  - Australian Animal Health Laboratory (AAHL), Australia;
  - *Friedrich Loeffler Institut* (FLI) , Germany;
  - *Istituto Zooprofilattico Sperimentale delle Venezie* (IZSVe), Italy.
- For foot-and-mouth (FMD) disease and vesicular diseases:
  - Project Directorate on Foot-and-Mouth Disease (PDFMD), Indian Centre for Agricultural Research (ICAR), India: FMD for South Asia;
  - *Istituto Zooprofilattico Sperimentale della Lombardia e dell'Emilia Romagna* (IZSLER), Italy: FMD and swine vesicular diseases;
  - National Veterinary Services Laboratories Foreign Animal Disease Diagnostic Laboratory (NVSL-FADDL), United States of America: FMD and other vesicular diseases in the Americas and the Caribbean;
  - Veterinary and Agrochemical Research Centre (CODA-CERVA-VAR), Belgium: vesicular diseases.

About 45 other applications are currently at various stages of the designation process. The designations of institutions for FMD, animal influenza, parasitology, wildlife, vector-borne diseases and veterinary epidemiology are in the final stages. Several are awaiting government endorsement, where delays are not necessarily related to government reluctance to provide endorsement but rather to cumbersome official communication channels. The designations of Reference Centres for morbilliviruses, ruminant mycoplasmoses, rabies, veterinary public health, brucellosis, African and classical swine fever, parasitic zoonoses, diseases at the animal–human interface, tuberculosis and paratuberculosis are undergoing internal FAO approval in principle. Applications from institutions interested in becoming FAO Reference Centres for laboratory biosafety and biocontainment are under evaluation.

In the event of an application not meeting the criteria (e.g., lack of a leading scientific role, inadequate biocontainment level and/or level of collaboration with the developing world), FAO invites the institution to reapply when its situation changes.

Information on FAO References Centres will be made publicly available on the Animal Production and Health Division (AGA) Web site[2] and on the Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases Global Animal Disease Information System (EMPRES-i) directory of laboratories.[3]

For further information please contact AGAH-Reference-Centre@fao.org.

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[2] www.fao.org/ag/againfo/home/en/index.htm

[3] http://empres-i.fao.org/eipws3g/#h=3

Wildlife, health and ecology

The role of bats in emerging zoonoses

Between September 1998 and May 1999, in Malaysia, humans and domesticated pigs suffered an outbreak of an unknown disease causing respiratory and neurological signs in both species. Within a few months, the causative agent was identified as a new virus belonging to the Paramyxoviridae family. During the course of the outbreak more than 1 million pigs were culled; 257 human cases were reported, of which 105 were fatal, and numerous surviving humans continue to suffer neurological signs (Parashar *et al.,* 2000). To date, there is neither a vaccine nor an effective treatment protocol for humans suffering from this virus (WHO, 2009).

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Bats in a cave

This novel virus, now known as Nipah virus, affects both pigs and humans and has caused clinical disease in Malaysia, Singapore, Bangladesh and India since 1998. Its natural reservoir host has been identified as fruit bats from the genus *Pteropus*. In Bangladesh, the virus made the jump directly from bats to humans, without a pig intermediate host; this jump was most likely associated with ingestion of fresh date-palm sap collected from trees where bats roosted or foraged. Outbreaks in Malaysia were caused by virus transmission from bats to pigs, and then from pigs to people. Since emerging in 1998, the virus has been identified in other domesticated species, including horses, goats and dogs, but only in areas where large numbers of pigs were infected (Iowa State University, 2007). In Bangladesh, there has been evidence of human–human transmission, although this is difficult to prove (WHO, 2009). With its implications for food security and public health, Nipah virus is one of the most concerning emerging diseases of recent times.

Proposed drivers of emergence of Nipah virus include intensified pig farming, variable climatic conditions around the time the disease emerged, and altered forest ecosystems leading to increased interactions among bats, livestock and humans; these drivers vary by outbreak location. In Malaysia, the main drivers for emergence included the establishment of pig farms within the range area of bats, high densities of pigs on farms maintaining the virus, and large numbers of pigs transported throughout the country. In southern Asia the situation was different; emergence was associated with increased contact between humans and bats – probably through fruit or palm syrup contaminated by bat saliva and faeces – and did not rely on pig populations as an intermediate host. Regardless of the specific cause, Nipah virus caused substantial negative impacts on livelihoods and food security, leading to the culling of 1.1 million pigs (at an estimated cost of USD 97 million) in Malaysia alone (Bin Jamaluddin and Bin Adzhar, 2011).

Over the past few years, a large number of emerging viruses have been identified in various species of bats; in some cases, bats have been identified as the main reservoir host. These viruses include severe acute respiratory syndrome (SARS), which resulted in more than 8 000 human cases in 23 countries; Hendra virus, causing deaths of humans and horses in Australia; and Ebola and Marburg viruses, which

cause a rapidly fatal viral haemorrhagic disease in humans (Li *et al.,* 2005; WHO, 2004; 2012; FAO, 2011). These diseases have given bats a bad reputation, and bats' important role in maintaining ecosystem health is often forgotten during the public alarm that is generated by disease incidents.

After rodents, bats (order Chiroptera) are the second most diverse mammal group in the world. The group includes more than 1 200 species that fall into two suborders: Microchiroptera or Megachiroptera. Bats within the group Microchiroptera are echo-locating, generally small and mainly insectivorous. The order Megachiroptera includes larger fruit bat species. Bats play two major roles in maintaining ecosystems, based on their main diet source. Insectivorous bats are the main predators of nocturnal insects, significantly reducing crop pests worldwide and providing a financially significant contribution to the agriculture sector (Kuntz *et al.,* 2011). It is estimated that these valuable pest control services save farmers in the United States of America between USD 3.7 billion and USD 54 billion a year (Cox, 2012). Fruit bats are generally found in tropical and sub-tropical environments, and are responsible for plant pollination and seed dispersal, which are important for healthy ecosystems and food security. In some regions, people rely on bats for their livelihoods, through the collection of bat faeces, called "guano", for use as fertilizer.

Managing zoonotic diseases related to bats requires multidisciplinary collaboration

Despite their importance in maintaining the health of plants and animals via the ecosystem services they provide, bats are disliked in many parts of the world, because of cultural myths and lack of knowledge. Managing zoonotic diseases related to bats requires multidisciplinary collaboration, with ministries of health, agriculture and forestry/environment working together to ensure that human, livestock, wildlife and ecosystem health are taken into account in the management strategy. To highlight the multidisciplinary issues associated with the management of bats, in November 2011, the Food and Agriculture Organization of the United Nations (FAO) published a manual on *Investigating the role of bats in emerging zoonoses: Balancing ecology, conservation and public health interest* (FAO, 2011). This provides information on bat ecology and the role that bats play in emerging infectious diseases, while emphasizing bats' importance in maintaining ecosystems that support human, plant and animal life. The manual is a resource for epidemiologists, natural resource professionals, veterinarians and others whose fieldwork focuses increasingly on bats. It is published in French and English, and is available in English online.[1]

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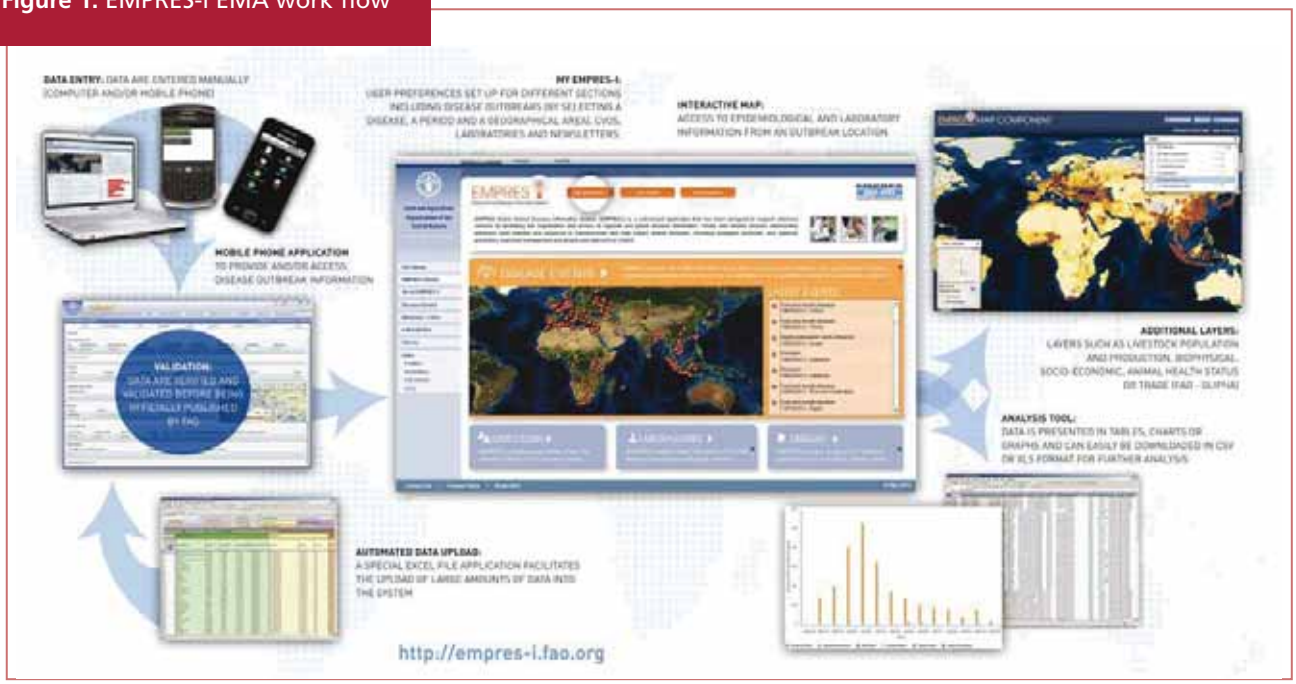
What is new in EMPRES-i?[1]

EMPRES-i EMA: an integrated tool for animal disease field surveillance

In response to the challenges that face animal health services in providing timely field surveillance and reporting, the Food and Agriculture Organization of the United Nations (FAO) has been exploring ways of using the expanding array of personal electronic devices to report key data from disease incidents in the field. Some FAO avian influenza field projects have started to use Small Message Service (SMS) and digital pen technology to provide simple reports on active disease surveillance activities. More recently, smartphones have been used to report a larger slice of information from the field to a database server, and FAO has been examining the possibilities of using this technology to report emergency disease information to the Global Animal Disease Information System (EMPRES-i).

As part of these efforts, an application (app) called the EMPRES-i Event Mobile Application (EMA) has been developed to enable smartphones to deliver disease information directly to the EMPRES-i database. The rationale for the app is that in some developing countries access to the Internet can be difficult, especially away from main population centres, while telephone networks have good signal coverage over wider areas, so rapid connection is possible while in the field.

Figure 1: EMPRES-i EMA work flow



[1] http://empres-i.fao.org

EMPRES-i EMA was designed to facilitate FAO officers and partners in providing disease information from the field. The application allows the user to enter key epidemiological data directly from the field, or to save the data on the device for transmission later. All the data entered are automatically georeferenced, so this key field is captured in EMPRES-i when the data are uploaded.

Once a report is submitted to the EMPRES-i database using EMPRES-i EMA, the data are verified and validated, and the submitter of the information can be contacted if necessary. Validated information is either published on the EMPRES-i public Web site or kept in the EMPRES-i internal database as confidential or sensitive, as appropriate.

EMPRES-i EMA allows direct access to the database through a "near me" mapping function, which provides users with a map based on georeferenced data on nearby outbreaks that are recorded in the EMPRES-i database. Outbreaks can be visualized on the map by defining/modifying two parameters: time period and distance from the user. By clicking on a dot on the map, the user in the field can see all the outbreak data that are entered in EMPRES-i.

EMPRES-i EMA is currently available for Blackberry™ devices and smartphones using Android™ technology; further developments will produce an adapted version for I-Phones™ and tablets, and add functions such as a list of animal disease cards that can be consulted from the field during epidemiological field investigations.

The app allows users to contribute to FAO's early warning activities and forecasting, and to receive real-time information on outbreaks in the field.

FAO plans to develop guidelines and undertake field trials through FAO projects, to validate the approach and resolve any problems or constraints. FAO will then promote the use of EMPRES-i EMA among its partners, including animal health services.

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Meetings

OFFLU's contribution to the WHO consultation on the composition of influenza vaccines for the Northern Hemisphere, 20 to 22 February 2012, Geneva, Switzerland

The Food and Agriculture Organization of the United Nations (FAO), the World Organisation for Animal Health (OIE) and their Network of Reference Laboratories, Epidemiology Centres and Groups of Experts on Avian Influenza (OFFLU) contributed to the World Health Organization's (WHO's) biannual meeting on vaccine composition held from 20 to 22 February 2012. This consultation process aims to provide national public health authorities and vaccine manufacturers with guidance on the selection of candidate viruses for use in the development of human vaccines. The latest genetic and antigenic data on H5N1 and H9N2 avian influenza to be generated through OFFLU were presented and matched with the most up-to-date epidemiological information on influenza circulation among animals worldwide.

At the February consultation, OFFLU shared 39 H5 virus sequences from Bangladesh, China (Tibet), Egypt, the Islamic Republic of Iran and Nepal. The viruses belonged to clades 2.2.1, 2.2.1.1 and 2.3.2.1 and were isolated from poultry and wild birds. For H9N2, the network provided 39 novel sequences originating from China, Egypt, the Islamic Republic of Iran, Nepal, Saudi Arabia and the United Arab Emirates. Viruses from Bangladesh, Egypt and Nepal were also antigenically analysed by three OFFLU laboratories – the *Istituto Zooprofilattico Sperimentale delle Venezie* (IZSVe) in Italy, the Australian Animal Health Laboratory (AAHL) and the Animal Health and Veterinary Laboratories Agency (AHVLA) in the United Kingdom of Great Britain and Northern Ireland – using a panel of ferret sera, provided by the WHO collaborating centre at St. Jude Children's Research Hospital in the United States of America. Results from antigenic and genetic analysis showed that no new human virus candidates needed to be selected for the main circulating H5N1 clades. The current vaccine candidates also showed sufficient protection against circulating H9N2 viruses.

One clade 2.3.4.2 candidate virus strain, selected during the previous consultation in September 2011, has been shipped from IZSVe to the United States Centers for Disease Control and Prevention in Atlanta, Georgia, to make it available to the entire WHO network of collaborating centres; the authorities of Bangladesh agreed to this transfer. This is the first time that an animal health laboratory has officially provided a vaccine candidate to the public health community.

More details on the outcomes of this consultancy process are available on the WHO Web site under "Antigenic and genetic characteristics of zoonotic influenza viruses and development of candidate vaccine viruses for pandemic preparedness".[1]

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[1] www.who.int/influenza/resources/documents/characteristics_virus_vaccines/en/

RESOLAB: fifth annual coordination meeting, 12 to 16 December 2011, Central Veterinary Laboratory, Bamako, Mali

The Food and Agriculture Organization of the United Nations (FAO) and the United States Department of Agriculture/Animal and Plant Health Inspection Service International Services (USDA/APHIS.IS), in the framework of the Regional Animal Health Centre of Bamako and in collaboration with the United States Agency for International Development (USAID) and the Joint FAO/International Atomic Energy Agency (IAEA) Division, organized the fifth annual coordination meeting of the West and Central Africa Veterinary Laboratory Network for Avian Influenza and other Transboundary Diseases (RESOLAB),[1] which was held from 12 to 16 December 2011 at the Central Veterinary Laboratory in Bamako, Mali. The opening ceremony was chaired by the Secretary General of Mali's Ministry of Livestock and Fisheries in the presence of the FAO Deputy Regional Representative for Africa, six FAO subregional representatives (for Burkina Faso, Ghana, Guinea, Mali, Mauritania and Senegal), the World Organisation for Animal Health (OIE) Representative for Africa and the African Union/Interafrican Bureau for Animal Resources (AU/IBAR) Director delegate.

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Group photo of the RESOLAB fifth annual coordination meeting

RESOLAB annual coordination meetings assess the progress made by member laboratories and their networks and define the main objectives for the following year(s).[2] They also provide an opportunity for discussing issues related to disease tests and testing, information reporting, regional and global approaches to diseases, ongoing animal health projects and initiatives, advocacy for ensuring laboratories' sustainability, and other themes. These annual gatherings have become an important technical forum for all Western and Central African veterinary diagnostic laboratories and their partners.

RESOLAB 23 laboratories

The meeting's main recommendations[3] stressed aspects of RESOLAB's governance and institutional structure (including linkages with regional economic communities) where improvements are needed; revitalization of the thematic sub-networks set up in 2010; an advocacy strategy for increasing Member States' support of national laboratories; ways and means of strengthening laboratories' position/involvement within animal health and veterinary public health programmes; ways of strengthening collaboration between epidemiological surveillance systems/networks and RESOLAB laboratories; and continuing capacity building activities

[1] www.fao-ectad-bamako.org/fr/-resolab,27-?lang=en
[2] www.fao-ectad-bamako.org/fr/final-report-of-resolab-5th-annual?lang=en
[3] The minutes and recommendations of the meeting are available at www.fao-ectad-bamako.org/fr/img/pdf/report_5th_resolab_dec2011_engl_F16jan_gd.pdf

Objectives of the RESOLAB meeting

The main purposes of this fifth meeting were to review and discuss:

- the activities and results of each national laboratory in the network and of RESOLAB coordination throughout 2011;
- RESOLAB governance, sustainability and funding issues;
- synergies and collaboration between RESOLAB and other projects such as USAID's IDENTIFY project; other networks such as EARLN, REMESA, the European Commission for the Control of Foot-and-Mouth Disease (EuFMD), and the Network of Reference Laboratories, Epidemiology Centres and Groups of Experts on Avian Influenza (OFFLU); and technical partners such as APHIS.IS and IAEA;
- the activities of thematic sub-networks on rabies, peste des petits ruminants, foot-and-mouth disease, and quality assurance, and projects or initiatives involving the laboratories of RESOLAB members;
- lessons learned from regional workshops held in 2011, and the results of inter-laboratory proficiency tests on the diagnosis of avian influenza and Newcastle disease;
- the status of transboundary animal diseases in the region;
- an update on FAO's mapping of RESOLAB laboratories;
- the outline of the RESOLAB 2012 action plan.

on thematic and transversal activities, such as the roadmap for a quality assurance system, laboratory biosecurity and biosafety, and public–private partnerships. Both national authorities and regional bodies asked the Coordination Committee, the Technical Committee and the Advocacy Group (which were set up in 2010) to increase their role in developing and disseminating advocacy documents for ensuring the network's future.

At the end of the meeting, all member countries affirmed their sense of ownership of the network, which they consider to be an essential tool for managing animal health and veterinary public health in their respective countries. Representatives acknowledged the need to ensure the sustainability of RESOLAB's operations through financial support from member countries and regional economical communities.

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Meetings for IDENTIFY project planning in the Congo Basin

The IDENTIFY project is a component of the United States Agency for International Development's (USAID's) five-year Emerging Pandemic Threats (EPT) programme, launched in October 2009. The project is implemented jointly by the Food and Agriculture Organization of the United Nations (FAO), the World Organisation for Animal Health (OIE) and the World Health Organization (WHO), and aims to strengthen laboratory diagnostic capacities within existing laboratory networks in the Congo Basin, South Asia and Southeast Asia. The countries targeted in the Congo Basin are Cameroon, the Central African Republic, Congo, the Democratic Republic of the Congo, Equatorial Guinea, Gabon, Rwanda, South Sudan, Uganda and the United Republic of Tanzania.

Since the IDENTIFY stakeholders meeting in Entebbe (Uganda) in November 2011, African beneficiary countries have not had the opportunity to meet and discuss progress in the IDENTIFY project's support to their laboratories, their common concerns and the best way of implementing the project at the national level.

To support the FAO-specific outputs of the IDENTIFY project, two three-day meetings were held in Libreville (Gabon) from 3 to 5 April 2012, for countries in the western Congo Basin, and Entebbe (Uganda) from 11 to 13 April 2012, for countries in the eastern Congo Basin. The objective was to present and discuss the best approach for FAO's implementation of the project's year 3, and to improve beneficiary laboratories' ownership of the project. Each meeting was attended by about 30 participants, including veterinary laboratory directors and chief veterinary officers of beneficiary countries, and representatives of OIE, the WHO Regional Office for Africa (WHO/AFRO), the African Union's Interafrican Bureau for Animal Resources (AU-IBAR) and FAO subregional offices, Emergency Centre for Transboundary Animal Disease Operations (ECTAD) regional offices and Headquarters.

During the meetings, participants shared and discussed the outcomes of the project so far, including results of the laboratory mapping exercise, assessments of the biosafety and biosecurity of laboratory premises, and staff training on the calibration and metrology of laboratory equipment. They reached agreement on the approach for implementing FAO's work plan for year 3 and on the activities to be implemented at the regional and national levels. The agreement included respective timetables, a monitoring and evaluation system, the roles and responsibilities of IDENTIFY national focal points, ways and means of improving collaboration with other components of the EPT programme, ways of improving linkages with epidemiology networks, and strategic approaches to improve project visibility and laboratory sustainability.

Objectives of the five-year IDENTIFY project

The objectives are to:

- enhance laboratories' ability to detect the diseases targeted by IDENTIFY – to a level of characterization that is appropriate to the laboratory's capability;
- enhance/support laboratories' timely reporting of IDENTIFY-targeted diseases to national authorities, to facilitate official notification to the appropriate regional and international organizations;
- laboratories' adoption or improvement of quality assurance practices, including biosafety and biosecurity measures, and their establishment of a comprehensive quality management system;
- laboratories' participation in relevant regional and international laboratory networks according to their respective abilities, disease priorities and responsibilities.

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News

Jan Slingenbergh departs

Jan Slingenbergh, who since 2009 has been Head of the Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases (EMPRES) – Animal Health and has overseen production of the *EMPRES Bulletin*, left the Food and Agriculture Organization of the United Nations (FAO) at the end of April 2012 for early retirement. As Jan himself puts it, he wishes to create more time for himself and also to go back to technical and policy work related to disease ecology, leaving the hectic roller-coaster to the next generation. We wish him well and hope to hear more from him in the future. His career in international animal health started in Africa. For FAO he spent the 1980s in Benin, Mozambique and Ethiopia, involved in a wide range of veterinary/public health topics including laboratory capacity development, tsetse and trypanosomoses, transboundary livestock disease control, and land use, animal production and animal health policies. He spent most of the 1990s and 2000s at FAO Headquarters in Rome, Italy, again working on a variety of topics: coordinating the FAO response to Old World screwworm control and prevention in the Arabian peninsula, acting as focal point in the Secretariat of the Programme against African Trypanosomosis, orchestrating studies on infectious disease dynamics in the Eurasian ruminant street and, from early 2004, concentrating on strategies against the build-up of the animal–human reservoir of influenza A viruses, particularly in eastern and southeastern Asia. His current focus is on the drivers and transmission ecology of disease emergence at the human–animal–ecosystem interfaces, and One Health.

New staff

Charles Bebay

Veterinarian Charles Bebay has recently joined the Animal Health Service (January 2012) as IDENTIFY Project Liaison Officer for sub-Saharan African. He has more than ten years of experience in project management in the animal health and livestock sectors in West Africa. Between 2009 and 2011, he contributed to rapid responses to transboundary animal disease emergencies as Response Veterinary Officer in the Food and Agriculture Organization of the United Nations' (FAO's) Crisis Management Centre – Animal Health. He also coordinated roll-out of the FAO *Good Emergency Management Practice: The Essentials* (GEMP) manual, including organizing the first regional workshop for West African countries, held in Entebbe, Uganda in November 2011, as a pilot for GEMP's promotion. His field competencies cover veterinary sciences, livestock and animal diseases in hot zones; and the preparation, implementation, evaluation, monitoring and funding mechanisms of projects.

Meetings and publications

Upcoming meetings and events

- FAO/OIE International Conference on FMD Control, Bangkok, Thailand, 27 to 29 June 2012 (www.fmdconference2012.com/background.html)
- 10th European IFSA Symposium, Aarhus, Denmark, 1 to 4 July 2012 (http://ifsa2012.dk/)
- Convention on Wetlands (Ramsar) Conference of the Parties (COP 11), Bucharest, Romania, 6 to 13 July 2012 (www.ramsar.ro/)
- 33rd Conference of the International Society of Animal Genetics, Cairns, Australia, 15 to 20 July 2012 (www.isag.us/2012/default.asp)
- Wildlife Disease Association 61st Annual Conference, Lyon, France, 22 to 27 July 2012 (http://wda2012.vetagro-sup.fr/)
- XXIV World's Poultry Congress, Salvador Bahia, Brazil, 5 to 9 August 2012 (www.wpc2012.com/)
- 13th International Society for Veterinary Epidemiology and Economics (ISVEE) Conference 2012, "Building Bridges – Crossing Borders", Maastricht, Netherlands, 20 to 24 August 2012 (http://isvee13.org/)
- 63rd Annual EAAP Meeting, Bratislava, Slovakia, 27 to 31 August 2012 (www.eaap2012.org/en/bratislava)
- UNEP-CMS Workshop on Migratory Landbirds in the African Eurasian Region, Accra, Ghana 31 August to 2 September 2012
- International Conference on Goats, Canary Islands, Spain, 24 to 27 September 2012 (www.iga-goatworld.com/1st-announcement-11th-international-conference-on-goats-september-24-27-2012_a128.html)
- 84 Executive committee meeting of EuFMD, Pirbright, United Kingdom of Great Britain and Northern Ireland, 2 to 4 October 2012
- Annual FAO/IFIF meeting, FAO Headquarters, Rome, Italy, 4 to 5 October 2012
- Convention on Biological Diversity (CBD) Conference of the Parties (COP 11), Hyderabad, India, 8 to 19 October 2012 (www.cbd.int/cop11/)
- EcoHealth 2012: Supporting Ecosystems, Supporting Health, Kunming City, China, 15 to 18 October 2012 (www.ecohealth2012.org/)
- 2012 European Scientific Conference on Applied Infectious Disease Epidemiology (ESCAIDE), Edinburgh, Scotland, United Kingdom of Great Britain and Northern Ireland, 24 to 26 October 2012 (http://ecdc.europa.eu/en/escaide/pages/escaide.aspx)
- 7th Session of the Intergovernmental Technical Working Group on Animal Genetic Resources for Food and Agriculture (2012), Rome, Italy, 24 to 26 October 2012 (www.fao.org/ag/againfo/programmes/en/a5.html)
- Open Session of EuFMD, Jerez de la Frontera, Spain, 29 to 31 October 2012
- VII Latin America Congress on Agroforestry Systems for Sustainable Animal Production, Belém do Pará, Brazil, 8 to 10 November 2012 (www.viicongresssolatinoamericanosapps.com/en/)
- 15th Asian-Australasian Animal Production (AAAP) Congress, Bangkok, Thailand, 26 to 30 November 2012 (www.aaap2012.ku.ac.th/)

FAO Animal Production and Health publications

- **FAO Animal Production and Health Working Paper No. 7:** *An assessment of the socio-economic impacts of global rinderpest eradication – Methodological issues and applications to rinderpest control programmes in Chad and India* (available at: www.fao.org/docrep/015/i2584e/i2584e00.pdf).
- **FAO Animal Production and Health Working Paper No. 10:** *How can animal health systems support small-scale poultry producers and traders? Reflections on experience with HPAI* (available at: www.fao.org/docrep/015/i2739e/i2739e00.pdf).
- **FAO Animal Production and Health Manual No. 12:** *Investigating the role of bats in emerging zoonoses – Balancing ecology, conservation and public health interest* (available at: www.fao.org/docrep/014/i2407e/i2407e00.htm).

Stop the press

Since the last *EMPRES Transboundary Animal Diseases Bulletin* there have been additional reports of transboundary animal diseases across the world.

African swine fever (ASF) continues to persist in the endemic southern regions of the Russian Federation, affecting backyard holdings and commercial pig production units. During the first half of 2012, the virus again jumped out of its endemic zone to the Republic of Karelia, beyond 63° north and 200 km from the border with Finland, and there is now a growing risk of it becoming endemic in the temperate forest zone in the centre of the eastern European plain. Particularly in Tverskaya Oblast, ASF cases in wild boar have been reported for more than a year (since May 2011). If the virus establishes itself in wild boar populations, several countries in the region – including Estonia, Latvia, Lithuania, Belarus and Ukraine – will be at risk of virus introduction from wildlife.

Peste des petits ruminants (PPR) in Africa is rapidly expanding beyond its traditional boundaries and now poses a major threat to northern and southern Africa and Europe. An incursion of PPR in 2008/2009 in Morocco was followed by the finding of PPR-sero-positive animals in Algeria in early 2011 and Tunisia in early 2012. In Bandundu Province, Democratic Republic of the Congo (DRC), the disease has been officially reported this year, with significant losses in livestock; it is now threatening neighbouring countries to the south of DRC. A Food and Agriculture Organization of the United Nations (FAO) Crisis Management Centre – Animal Health (CMC-AH) mission was deployed in April 2012 in DRC, and FAO has prepared a Technical Cooperation Programme (TCP) project to support the government's response. A vaccination campaign is planned for non-affected areas of the country.

Schmallenberg virus (SBV) continues to be reported in Europe; the disease was reported in Fyn, Denmark on 7 June 2012, bringing the number of countries where the disease has been identified to a total of nine.

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