Animal Health Management

Review of tools available for disease control

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INTRODUCTION

This module provides broad concepts and principles of some of the tools that are available for animal health management. Modules on each of the tools are available that explore them in more detail.

Veterinarian with protective clothing in the field

Storage of samples in liquid nitrogen

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Veterinary medical supplies

Managing animal health involves the prevention, control and if possible eradication of animal diseases. The eradication of rinderpest announced by the World Organisation for Animal Health (OIE – *Office International des Épizooties*) in 2011 is regarded as a global triumph for animal disease control and has sparked hopes that it will be possible to eradicate other important transboundary animal diseases. A number of features made the eradication of rinderpest possible. The serious and fatal nature of the disease and the fact that cattle, in general the most important livestock species, were affected, assured strong interest on the part of the producers and international organisations involved in the control of animal diseases. The virus was unable to survive for long outside a living host, there was no long-term carrier state, and there was a highly effective vaccine. Most of the serious diseases of livestock lack one or more of these favourable characteristics but there are tools that assist in their management even if eradication is not a realistic possibility.

The aim of managing animal health is to minimise the negative effects of animal diseases on animal production and welfare, trade in livestock and livestock products, and human health. It involves preventing outbreaks of epidemic diseases and managing endemic diseases in cost-effective ways that minimise their impact on production, trade, livelihoods and human health and prevent their spread to areas where they are not endemic. The ability of animal health service providers in both the public and private sector to effectively manage animal health depends on knowledge of the diseases involved and access to information and tools as required.
Some of the tools available for managing animal health, **for which details are provided in dedicated modules**, are the following:

- Surveillance
- Participatory epidemiology

- Information systems
- Communication
- Farmer awareness and education
- Laboratory diagnostics
- Risk assessment
- Contingency planning and simulation exercises
- Modelling
- Vaccination
- Chemotherapy
- Biosecurity
- Segregation of populations at risk or posing a risk
- Animal identification and traceability

These tools will be discussed briefly in terms of what they imply and how and when they can be applied, as well as their practicality and acceptability. While some, like laboratory diagnostics, are not negotiable, others, for example the use of veterinary cordon fences to separate wildlife from livestock, are controversial.

Management of diseases is dictated by whether they are endemic or epidemic or exotic. This of course varies from country to country and sometimes between different areas within a country. A large number of so-called transboundary animal diseases (TADs), i.e. diseases that have serious consequences and a high potential for spread across international borders, are endemic in sub-Saharan Africa but have been eradicated elsewhere, in particular North America and Western Europe. Some of them, for example African swine fever (ASF), continue to have devastating effects in spite of being endemic, while others, for example foot and mouth disease (FMD), usually cause only mild disease but result in market exclusion. In order to attain market access to countries where FMD has been eradicated, the control measures required of endemically infected countries are out of proportion to the effect of FMD on local herds. In southern Africa, where African buffaloes (*Syncerus caffer*) are the main source of infection for cattle, the control measures designed to separate wildlife from domestic livestock (e.g. game proof fences) have a negative effect on biodiversity conservation. The restrictions imposed on livestock owners in areas adjacent to wildlife conservation areas are difficult to accept because in extensively kept cattle in sub-Saharan Africa the manifestations of FMD are usually mild.

Sub-Saharan Africa is also host to a variety of erosive vector-borne diseases like theileriosis, heartwater, babesiosis, anaplasmosis and trypanosomosis that cause production losses and sometimes high mortality where they do not exist in a state of endemic stability.

Managing exotic diseases involves ensuring that measures are in place to keep them out, and ensuring that capacity exists to mount a rapid and effective response if an exotic disease is introduced into a free country or area.
Managing epidemics means applying the measures needed to prevent spread and bring an end to an epidemic as rapidly and cost-effectively as possible.

Managing endemic diseases is largely a farm-level activity and involves preventive and control measures aimed at reducing the negative effects of the disease and if possible eliminating it altogether from herds. Tools for managing animal health can be divided into three broad categories:

- Tools for gathering and disseminating information about animal health
- Tools to support strategic planning for and evaluation of disease prevention and control interventions
- Tools used for disease prevention and control interventions.

INFORMATION MANAGEMENT TOOLS

Surveillance for livestock diseases

Surveillance for livestock diseases is a core responsibility of the veterinary services in any country. Firstly, it enables early detection of serious disease problems that could cause severe economic losses to producers and the country. Secondly, it protects human health through the early detection of zoonotic diseases. Thirdly, the information gathered through surveillance forms the basis for certification regarding the health status of a country or zone.

Because of the importance of serological samples in active surveillance programmes for particular diseases, the concept that surveillance consists of collecting blood samples and sending them to the laboratory is widespread. Surveillance that depends only upon the detection of antibodies offers a very narrow view and is doomed to fail to deliver all the information needed. For example, it does not include a strategy for the detection of active disease in the acute phases, before antibodies have developed, and it ignores the enormous potential of abattoir surveillance to provide information about the animals that are being sent for slaughter for human consumption. A holistic approach to surveillance is therefore required, to ensure that the information obtained is of high quality. This is emphasised in a manual for animal disease surveillance prepared by OIE, which, after an introductory section, contains sections on the design, implementation, assessment and evaluation of a surveillance programme or system; on data sources for the system; and on the tools used to implement the system.

Definitions

Surveillance: 'The systematic ongoing collection, collation and analysis of information related to animal health and the timely dissemination of information to those who need to know so that action can be taken' (OIE 2011).

Surveillance: 'All regular activities aimed at ascertaining the health status of a given population with the aim of early detection and control of animal diseases of importance to national economies, food security and trade' (Paskin 1999).
These definitions describe what is known as passive surveillance. 'Active' surveillance involves frequent and intensive efforts to establish the presence of a disease in an area.

Monitoring: 'The intermittent performance and analysis of routine measurements and observations aimed at detecting changes in the environment or health status of a population' (OIE 2011).

Monitoring: 'All activities aimed at detecting changes in the epidemiological parameters of a specified disease' (Paskin 1999).

Passive surveillance

Although the term given to the ongoing activity of gathering information to ascertain the health status of an animal population in an area or country is 'passive' surveillance, the approach to it should be anything but passive. Every possible source of information should be tapped as actively as possible.
Sources of information about the occurrence of animal diseases include:

- Animal health officers in the public sector
- Veterinarians in the private sector
- Veterinary diagnostic laboratories
- Animal health training facilities
- Abattoirs and livestock markets
- Agricultural extension officers and community-based animal health workers
- Livestock producers
- Other stakeholders and role players in livestock development and trade (traders, non-governmental organisations including animal welfare organisations)
- Human health services
- Wildlife conservation officers
- Hunters
- Field biologists (e.g. entomologists and acarologists who study veterinary parasites, biologists who study invertebrates that serve as human food).

Animal health officers

In order for animal health officers (veterinarians and paraveterinary professionals) employed by the state to obtain as much information as possible in a structured manner, a plan for surveillance activities should be established that will enable each animal health officer to visit as many livestock producers as possible in his/her area according to a predetermined timetable. Realistically, this will depend on the size of the budget of the animal health services. A concerted effort should be made to combine surveillance with other activities, for example parasite control and vaccination campaigns. While government-supported dipping campaigns have traditionally been combined with surveillance for FMD in many countries, the opportunity for contact with livestock owners and physical examination of animals should not be restricted to surveillance for one disease only.

Private sector veterinarians

In some countries legislation exists that compels reporting of notifiable diseases by all veterinarians, including those in the private sector, but to ensure compliance with legislation, and to obtain information where legislation does not exist, the good will of the veterinarians in the private sector is vital. In most developing countries, there are relatively few veterinarians working in the private sector. They usually serve commercial livestock producers who can pay for their services, or are employed by pharmaceutical and feed companies. It is vital to establish a good relationship with these veterinarians, since their communication of diseases may be hampered by issues of protecting client interests and confidentiality.

Taking samples at an abattoir

Veterinary laboratory, Lomé, Togo

Veterinary diagnostic laboratories are potentially a source of high quality information about animal diseases, since only they can scientifically confirm diagnoses. Their importance for surveillance is discussed further below. However, it has been pointed out that the information emanating from veterinary laboratories represents the tip of the iceberg. Specimens for diagnosis will only reach the laboratory if (1) the livestock owner summons veterinary assistance, and (2) the government animal health officer or private veterinarian submits specimens for laboratory examination to confirm his/her field diagnosis. The laboratory therefore represents the summit of a pyramid that contains much more information of potential value to surveillance systems. The imperative for laboratories to operate on a cost-recovery basis has further reduced their potential as a source of information about animal health status. Nevertheless, diagnostic laboratories that function well are an invaluable resource, and animal health officers, private veterinarians, extension officers and even livestock owners should be trained to take samples and send them to the laboratory. Mandatory testing of quarantined animals and products provides a potential source of information of diseases that may be spreading, sometimes in a subtle manner through subclinical carriers, e.g. contagious bovine pleuropneumonia, equine infectious arteritis and contagious equine metritis.

Animal health training facilities

Veterinary faculties and agricultural training colleges are a potential source of information about animal health, since the students receive practical experience by exposure to livestock. Veterinary faculties in particular usually offer clinical services and may have even more opportunities to observe sick animals than the government veterinary services. Building a good relationship with these educational institutions is of vital importance for surveillance systems, since their priorities differ from those of the national veterinary services, and the need to report on the disease situation is easily overlooked.

Abattoirs and livestock markets

Abattoirs are correctly referred to as ‘the post mortem hall of the nation’. Since veterinary meat inspection is mandatory at least at larger abattoirs, these facilities offer a unique opportunity to collect specimens of abnormal conditions for diagnosis, record the occurrence of easily recognized diseases, and if necessary trace the farm or area of origin and conduct further investigations. The disadvantages are that the great majority of the animals presented for slaughter at abattoirs are healthy, and that, in developing countries, the great majority of animals are slaughtered elsewhere. Nevertheless, abattoir monitoring forms an essential part of disease surveillance, and also offers an opportunity to sample the meat offered for sale for human pathogens such as salmonellas and *Escherichia coli*.

Abattoirs offer an opportunity for monitoring disease

Holding facilities at abattoirs and places where livestock are brought for sale (e.g. sales pens, auction yards, livestock markets) offer an opportunity to carry out visual inspection of live animals destined for sale. Disease often prompts owners to sell animals in order to reduce expected losses, and the animals may be showing clinical signs of disease when offered for sale.

Agricultural extension officers and community-based animal health workers

Most countries have a well-developed agricultural extension service. Extension officers are usually more numerous and cover smaller areas than animal health officers, but they may have little knowledge of animal diseases. It is vital to provide information and training for them, and to ensure that the links between the extension services and the animal health services are strong.

In some countries, basic animal health services are provided by community-based animal health workers (CAHWs), since it is recognized that livestock producers in remote rural areas may not have access to any veterinary services. The CAHWs are members of communities who have received basic training in primary animal health care and are therefore better equipped than most of the community to recognize and report animal diseases. Since community-based animal health care systems necessitate appropriate veterinary supervision, links with veterinarians either employed by the state or by NGOs are well established and provide regular lines of communication that do not exist elsewhere. Good results of using CAHWs in surveillance activities have been reported.

Livestock producers

Livestock owners are one of the best sources of information (photograph courtesy of Geraldo Dias, Universidade Eduardo Mondlane,Mozambique)

Livestock producers offer, without any doubt, the greatest potential for obtaining information about farmed animal diseases and sometimes wildlife diseases. They or their helpers are in daily contact with their animals, are aware of changes in measurable parameters such as egg and milk production, and make the decision as to whether to consume or otherwise dispose of animals that become sick or die. The challenge is to devise ways to obtain the information, and to reassure the livestock producers that the information will not place them at a disadvantage by the application of control measures that will do far more damage to their livelihood than the disease itself. It has also been demonstrated that disease reporting by livestock owners is encouraged by the provision of advice and support whether or not the condition reported is of national interest, and discouraged when it is clear that the recipients of the information are only interested in particular diseases that may be of little interest to the farmer, for example foot and mouth disease, or brucellosis in the absence of abortions.

To obtain maximum value from disease reporting by livestock owners, it is necessary to provide educational material in the form of "health packages" (e.g. posters, videos, booklets or manuals and leaflets covering a range of health and production issues) that enhance their own knowledge about livestock diseases and helps them to manage those diseases in their own herds or flocks.

Other stakeholders and role players

Besides the main actors listed above, there are numerous participants in the livestock industry who can play a role in surveillance. These include development agencies and non-governmental organizations involved in promoting livestock production and trade or animal welfare, and beneficiaries such as livestock agents, butchers, and processors of livestock products whose livelihood could be threatened by animal diseases. The value of their participation in surveillance cannot be over-estimated.

Butcher in the market, Lomé, Togo

Human health services

Unfortunately, in the case of zoonotic diseases, human health services sometimes provide the initial information about an animal disease event. Thus the death of a human being due to rabies may be the first indication of the presence of the disease in an area. The death of a human as a result of highly pathogenic avian influenza, a rare event indeed given the duration of the outbreak and the extraordinary number of people who must have been exposed to infection, has nevertheless served in several countries as the first indicator of the presence of the disease in chickens. It is also reported that the first cases of Rift Valley fever in outbreaks that have occurred in Madagascar have invariably been in humans. It would seem, therefore, that human clinics and First Aid posts should be added to the list of sources of information for animal diseases.

Rural clinic, Madagascar

The 'One Health' concept ideally integrates surveillance for animal and human diseases and creates an unprecedented opportunity for cooperation between providers of human and animal health services in gathering and sharing information, preventing zoonotic disease outbreaks and responding to crises related to outbreaks of zoonotic diseases if they do occur. The concept is the subject of a **dedicated module** and underpins the concept of integrated management livestock and wildlife health and production.

At times the media and/or the general public are the first to pick up on an animal disease event. Usually the veterinary services will be approached for more information, and it is useful to provide a telephone number that will ensure that inquiries will reach the appropriate persons, and will provide an opportunity to follow up on the event.

Wildlife conservation officers and hunters

Surveillance for diseases in wildlife is challenging because in general wild animals are not under close observation on a daily basis. Involving wild life conservationists down to the level of game guards in surveillance for animal diseases can expand the information base in a valuable way. Some initiatives have been taken in this respect in the Great Limpopo Transfrontier Conservation Area in southern Africa. Involving hunters in surveillance also has potential. In parts of Europe hunters are actively involved in disease surveillance and control programmes among wild boars and other wildlife species that are hunted on a regular basis. Zoological gardens are another source of information about circulating diseases as not only do they maintain large collections of captive wild animals but they also often serve as a focal point to which the public bring sick wild animals and these are of particular interest in monitoring diseases circulating in urban wildlife.

Field biologists (entomologists, acarologists and other zoologists)

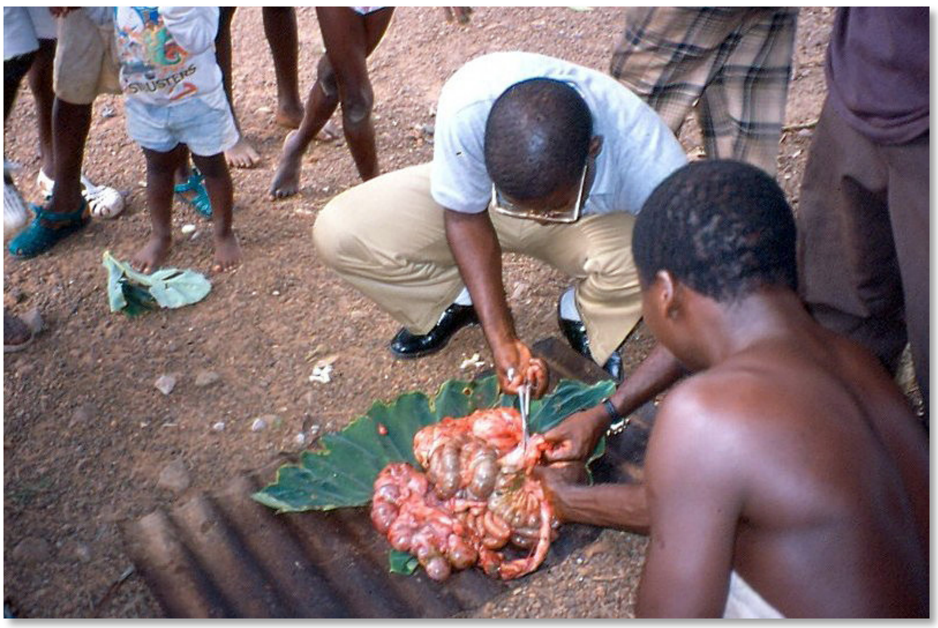
Liaison with biologists working in the field of parasitology and other branches of invertebrate biology can provide valuable allies for vector surveillance. The health of honey bees and aquatic vertebrates is of veterinary interest because of their importance as food or food producers but recognising their diseases is mainly done by biologists because it is not a traditional veterinary speciality. In particular, the multi-disciplinary involvement in health problems of honey bees has provided a major contribution to surveillance and reporting of outbreaks of disease that can affect honey production.

Means of gathering information for surveillance

Information may be gathered by the following methods:

- Visual inspection – carried out by animal health officers or trained lay persons (e.g. extension officers, CAHWs);
- Interviews with livestock owners, usually supported by questionnaires;
- Rapid Appraisals and Participatory Epidemiology – usually used in traditional rural communities;
- Serological surveys;
- Collection of other samples such as blood smears and faeces, and abattoir samples to be tested in the laboratory, for example to detect possible human pathogens such as salmonellas;
- Perusal of records and databases where collected information is stored;
- Perusal of disease information dissemination systems such as ProMed.


Taking samples from live animals for surveillance



Taking samples during post mortem examination

Participatory disease surveillance/epidemiology

The technique of participatory disease surveillance was first developed under the Global Rinderpest Eradication Programme to enable detection of rinderpest in remote communities where livestock owners were sometimes nomadic and often illiterate. The concept is based on the fact that subsistence livestock owners often have an excellent knowledge of the diseases that affect their animals and can contribute a great deal of epidemiological information provided the approach used is acceptable and understandable. Rural appraisal methods are used to elicit the information that exists in local languages and terminology in order to develop case definitions for the diseases and to be able to prioritise diseases according to the impact that they have on their owners' livelihoods. Using techniques like mapping it is possible to gain information about the epidemiological patterns of the diseases and to allow the owners to participate in planning disease control programmes that will be tailored to their needs rather than to the perceptions of researchers and animal health managers. The technique was useful in locating some of the last foci of rinderpest in Pakistan and the Horn of Africa. It has been used successfully for other diseases like PPR and, combined with a simple cell phone reporting system and interventions by response teams, has provided considerable information about HPAI outbreaks in Indonesia. The technique is more fully described and evaluated in publications and in a **dedicated module on the subject**.

Active surveillance for particular diseases

Sometimes it is necessary to undertake more intensive surveillance for a particular disease, for example:

- when a neighbouring country reports an outbreak close to the border,
- when an outbreak has been detected within one's borders and it is necessary to find out whether it has spread,
- after an outbreak has apparently been eradicated, to ensure that there are no further foci of disease,
- when a country is applying for recognition of zonal freedom from one of the remaining two diseases (FMD, contagious bovine pleuropneumonia) for which this is available (the third, rinderpest, has been declared eradicated in 2011), or for of a particular level of risk for BSE,
- in the establishment of compartments that can be declared free of particular diseases,
- when it is likely that passive surveillance will not provide sufficient information, e.g. rabies.

Sometimes active surveillance may be undertaken to determine the prevalence of a particular disease. This should always have a clear purpose, for example to determine trends over a period of time, to determine the effect of an intervention by comparing the prevalence before and after, or to estimate the level of risk of a zoonotic disease.
To ensure that the data collected are representative and will provide the required level of

confidence in the results, the campaign needs to be designed in line with epidemiological principles.

Feedback

An important aspect of surveillance that is often overlooked is the necessity to provide feedback to those who have provided information or have submitted samples for laboratory testing. Reporting back to the field officers, livestock producers and others who have assisted in data collection will encourage them to continue to participate in and contribute to surveillance. Failing to report back, on the other hand, has an extremely negative effect and informants lose all interest in the programme. Feedback should be wherever possible accompanied by advice on how to manage any diseases and conditions identified. If the information leads to the necessity of applying control measures that may be unpopular with livestock owners, the situation must be handled as sensitively as possible and with as much explanation as is necessary to ensure that the livestock owners will support and participate in the intended action.

Information systems and data management

Animal disease information systems

A **dedicated module** on the subject of animal disease information is available. In summary, various information systems for animal diseases are available. The most widely used source of global information on animal diseases is the OIE website. The OIE WAHID (World Animal Health Information Database) interface offers detailed information by disease and by country from 2005 as well as providing access to information gathered between 1996 and 2004 in the Handistat II archive. The information is derived from six-monthly and annual reports submitted by member countries as well as emergency and follow-up reports on outbreaks. Naturally, the quality of the data depends on the quality of the reporting by the different countries, and failure to submit reports for particular periods or late submission of reports reduces the completeness and usefulness of the information. The OIE makes every effort to encourage countries to report rapidly and completely and, in spite of non-compliance by some countries, the WAHID interface provides an excellent source of information. OIE also offers an opportunity to subscribe, without charge, to their e-mail alert system which allows subscribers to receive e-mails when an emergency situation has arisen in a country as well as information about simulation exercises scheduled to take place.

Another excellent source of rapid information is the PromedMail system of e-mail reports that are based on media reports and reports from subscribers as well as OIE reports about disease events worldwide. The system is available free of charge although users are encouraged to donate if possible to support this extremely valuable information service.

The AU-IBAR also encourages countries to report animal diseases (all African countries with the exception of Morocco are members of AU). The information from the reports is published in the Panafrican Animal Health Yearbook, which is published as soon as possible after the end of the relevant year. It is thus not an emergency reporting system but a useful synthesis of the situation with respect to the most important animal diseases across the continent.

The EMPRES Bulletin, available on the FAO website, provides information on major animal disease events, and the i-EMPRES database provides detailed information and maps of outbreaks of selected important diseases (e.g. FMD, RVF); the information is mainly derived from the OIE reports.


Computer-based systems and mobile devices have revolutionised data management and communication

Data management

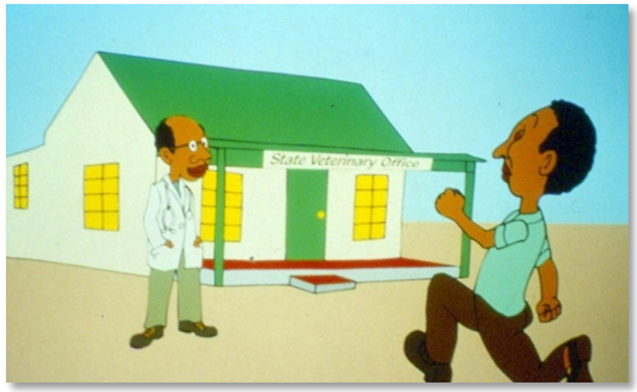
Information that has been gathered is not useful unless it is well managed in such a way that it can be

- permanently stored,
- easily retrieved,
- properly interpreted and analysed, and
- used for the purpose for which it was collected.

Nowadays information is usually stored and managed electronically. Various programmes are available for storing and analysing epidemiological data. The programme selected will depend on the training and preferences of the veterinary epidemiologists involved in surveillance.

It is important to remember that the best systems can fail, and that the backing up of data is extremely important to ensure that the effort made in collecting the information has not been wasted. Back-ups should be stored in a different place to the system, preferably in another building, in case of fire.

Communication



Communication of animal disease events should always be as rapid as possible

Communication in the context of animal health management refers to the provision of information about animal health status, diseases and disease control to stakeholders and interested parties at all levels of the community. This implies that the information will take various forms, depending on the level of technical knowledge of the target recipients. In preparing communications it is therefore important to consider the following:

- Who is the target recipient or audience?
- What is the content of the message or communication?
- What is the best way to put the message across, considering the target and the content?
- What are the indicators to establish whether communication was successful?

The target audience will determine the way in which communication is effected, including such important factors as the selection of suitable media for communication, the language/s chosen for communication, and the use of illustrative material.

Targets for communication by animal health managers

- International bodies (e.g. OIE)
- Politicians and administrators (e.g. Cabinet Ministers, Directors (national and provincial), provincial governors)
- Other animal health professionals
- Human health professionals
- Extension officers
- Livestock producers
- Other role-players in the livestock industry (traders, agents)
- Consumers of livestock products
- The general public

Information that must be communicated

- The occurrence of disease outbreaks and emergencies
- The importance of maintaining a good animal health status
- Information about diseases of livestock and zoonotic diseases
- Regulations governing the keeping, movement, sale and slaughter of animals

Means available for communication

- Reports (these may be transmitted in hard copy or by various mobile devices such as cell phones, digital pens and other new generation electronic devices)
- Policy briefs
- Public media (television, radio, newspapers and magazines)
- Lectures and presentations

- The internet
- Scientific publications
- Training and extension materials (hard copy, electronic)
    - For use by animal health officers and extension officers
    - For farmer-to-farmer extension

Key indicators for monitoring the success of communication

- Response of target audience
    - Actions resulting from the communication
    - Requests for further information

Farmer awareness and education

Farmer awareness and education in terms of animal diseases are critical for managing animal health. Knowledge and awareness of diseases of their animals ranges from an in-depth knowledge and awareness that includes coping mechanisms among traditional livestock farmers to an almost complete lack of knowledge on the part of new entrants to livestock farming. Even in communities with a long history of working closely with livestock, for example some of the African pastoralists, the level of understanding of diseases varies, for example in terms of whether the vectors of the diseases are recognised or not. It is important when conducting awareness campaigns or providing farmer training to find out what the level of knowledge is and building on that to ensure that the audience takes ownership of the information. If there are misconceptions it is important to deal with them diplomatically and if possible build them into the correct information, which might otherwise be rejected in favour of a long-held belief.

Veterinary diagnostic laboratory services

Veterinary laboratory, Kabete, Kenya

An efficient laboratory diagnostic service is a vital element of surveillance. The OIE has recognized that certification should be backed up by laboratory confirmation. It is also clear that disease control measures that cost money to put in place and cause, at the very least, inconvenience to livestock producers and sometimes a wider range of people, should not be instituted without confirmation of the diagnosis, which can only be provided by a laboratory.

Veterinary laboratory diagnostic services may be provided by government, parastatal, or private laboratories. The OIE viewpoint is that the laboratory should be under the control of the veterinary authorities, but this is not always possible. In developing countries, it may be necessary to depend on laboratories in other countries for the diagnosis of some diseases, particularly diseases that are not endemic in the country and that require a high level of containment, such as foot and mouth disease.

For a laboratory to function efficiently, there are certain basic requirements:

- Qualified and experienced staff,
- Adequate laboratory equipment in good working order,
- Infrastructure to support the activities of the laboratory, including a constant water supply, a constant electricity supply, and an adequate communications system.

Increasingly, for laboratory results to be accepted as credible, there is a need not only to apply a quality management system that complies with the international standard for analytical and testing laboratories, ISO/IEC 17025, but to provide proof of compliance through accreditation by a third party organisation mandated to audit and accredit quality systems. Quality management includes ensuring that the tests used have been validated both for the conditions in which they are used in the laboratory and the species for which they are used, e.g. a test developed for use in cattle may not necessarily give accurate results if used in wildlife.

Veterinary laboratories in developing countries are often hampered in their efforts to provide a good diagnostic service due to a number of constraints that include poor infrastructure, lack of equipment and, perhaps most importantly, lack of experienced staff. Donor organisations have ensured that veterinary laboratories in developing countries have received a great deal of support in terms of equipment and training, but this help has not borne fruit for the following reasons:

- Infrastructural problems have not been addressed;
- Equipment has rapidly ceased to function or has never been installed owing to lack of technical capacity to install, maintain, and repair it;
- Staff members cannot put their training into practice either because of the above problems, or because the training was inappropriate to the needs of the country, or because the culture of using a veterinary laboratory is poorly developed and very few if any specimens are received for testing.

The problem of lack of specimens is compounded by the fact that the service either is poor or is perceived to be poor, so that field veterinarians and livestock producers are reluctant to make use of it. Even when laboratories are fully subsidised and cost recovery is not attempted or prices are symbolic, the effort of getting the specimens to the laboratory is too great if the results are not expected to be useful.

Paradoxically, even in the face of other constraints, increasing the number of samples submitted will almost inevitably improve the quality of the service, because it stimulates the people in the laboratory to do more.

The blame for a poor diagnostic service may not lie entirely at the door of the laboratory. Providing a good diagnostic service depends heavily upon receiving adequate and appropriate samples, in a good state of preservation, with as much information as possible to permit the laboratory to select and perform the appropriate tests. Some of the problems of perceived poor service will be overcome if the laboratory provides guidelines, and if possible training, for the submission of samples and makes available the necessary materials for collecting samples (swabs, specimen jars, preservatives, and if possible simple cool boxes to transport chilled specimens). Additionally, no field officer should be without the basic instruments necessary to perform a *post mortem* examination in the field. It is also important for field officers and other submitting specimens to the laboratory to have a basic understanding of the tests performed and to be able to interpret the results.

TOOLS FOR ANIMAL HEALTH MANAGEMENT PLANNING AND EVALUATION

Risk analysis

Risk analysis is recognised as one of the most important tools for animal health managers. One of its major applications is in the field of import and export, where the SPS agreement of the WTO demands that non-tariff trade barriers should be science-based. A properly performed risk analysis provides the necessary scientific basis for the decision to accept or reject a commodity for import, as well as to argue that a commodity for export presents an appropriate, or acceptable, level of risk. The importance of risk analysis increases with general acceptance of the concept that "zero risk" is impossible, and that it is therefore necessary to determine the level of risk posed by any particular commodity. Increasingly, risk analysis is applied to aspects of animal health management, such as determining strategies for control of transboundary diseases. By doing this, resources can be directed at mitigating the most serious risks rather than spreading them over the whole spectrum of risks, some of which may not be applicable in the country involved. It is also applied to the planning of surveillance programmes, so that surveillance can be targeted at the areas of highest risk.

Components of risk analysis

Risk analysis has four components:

- Hazard identification
- Risk assessment
- Risk management
- Risk communication

Hazard identification

The following steps are required for hazard identification:

- Describe the commodity or activity for which the risk analysis is to be performed (e.g. importation of fresh meat, frozen semen, day-old chicks, stud heifers; movement of animals into a new area; holding a livestock auction);
- Identify the risk (e.g. introduction of FMD);
- Decide whether the risk actually exists (i.e. does FMD exist in the area from which commodities or animals are to be moved, and could those particular animals or commodities transmit FMD?);

- Decide whether the status of the destination of the animals or commodities is different from the status of the area of origin.

In identifying hazards it is important to take all of the evidence into consideration and if necessary obtain expert opinion to ensure that the final decision is science-based and defensible.

Risk assessment

When a hazard has been identified and carefully described, the next step is to assess the level of risk posed, based on the following information:

- Evaluate the potential of the hazard (i.e. the commodity or animal) to cause infection by estimating the probability that it will shed the pathogen into the environment;
- Evaluate the probability of the pathogen, if shed, reaching a susceptible population;
- Estimate the consequences of infection should it occur;
- Using this information, decide what the level of risk is for the hazard to cause a serious disease event.

Risk management

In order to decide on an approach to risk mitigation, or risk management, the following steps may be taken:

- Risk evaluation – comparing the risk with the country's appropriate level of protection. This involves evaluation of the risk analysis report and, if necessary, obtaining further information;
- Option evaluation – exploring the options available for mitigating the risk if it is regarded as unacceptable (e.g. permit importation or movement with minor restrictions, permit importation or movement under specified conditions, prohibit importation or movement);
- Implementation of the chosen option by acting on the risk management decision and making sure that the measures to manage the risk are in place;
- Monitoring and review of the results, to verify the appropriateness of the option chosen through an auditing process to ensure that the intended results are being achieved.

Risk communication

Risk communication in a narrow sense refers to the risk analysis report, in which the level of risk and the process used to arrive at that conclusion is described. It also refers to the process of communicating the risk to the relevant stakeholders.

In the widest sense, it also includes all of the communications that contribute to the process of hazard identification and risk assessment, so that the sources of information are identified (e.g. literature sources, web-based information, personal communications, expert advice).

The OIE rightly recommends communication with stakeholders such as the exporting authority, domestic and foreign industry groups, domestic livestock producers and consumer groups, and any other identified groups or bodies that will be affected by the decision. As the different groups will have strong and usually conflicting interests in the outcome of the risk analysis, it is vital that these interests should not influence the outcome of the risk analysis, which should be based on science alone.

Type of risk analysis

Risk analysis may be qualitative or quantitative.

Quantitative risk analysis is a highly specialised science which should only be performed by people who have specialised in that field if the results are to be credible. It furthermore depends on the availability of high quality quantitative data, without which the results will be meaningless even if the correct methodology is applied. Because detailed and accurate information is rarely available in the animal health situation, particularly in developing countries, qualitative risk analysis offers the safest option and is recommended by the OIE.

When performing qualitative risk analysis, the level of risk may be categorised as low, medium, or high, or ranked on a scale of 1 – 5 (which would effectively represent very low, low, medium, high, very high).

A simple qualitative risk analysis would be as follows:

Hazard identification: Chilled vacuum-packed beef for importation from a country that does not have FMD-free status recognised by the OIE into a country which is recognised by the OIE as free from FMD without vaccination.

1. Can the beef harbour infective quantities of FMD virus?

- o If the beef is deboned and lymph nodes have been removed, the answer is No, and the risk analysis may be abandoned
- o If the beef contains bone and lymph nodes, the answer is Yes – proceed to 2.

2. What is the probability that the possibly infected beef will come into contact with live susceptible cloven-hoofed animals?

- If the meat is destined for sale in a single urban retail outlet in an up-market area that supplies individual customers for home consumption, the probability of contact with cloven-hoofed animals is probably low, although there is a theoretical possibility that domestic garbage from any source might be exposed to scavenging livestock or used as swill feed, particularly in developing countries.
- If the meat is destined for sale to a restaurant or hotel chain from which kitchen swill may possibly be fed to animals such as pigs, the probability of contact with cloven-hoofed animals is medium to high.
- If the meat is destined for sale to local processing and manufacturing plants the risk would depend on the degree of control over waste disposal as well as whether the final processed products contained tissues that could harbour the virus.

3. What would the consequences be if the pathogen infected a susceptible population?

- Since the pathogen is FMD virus, the consequences must be rated as serious.

The communication would therefore indicate that, depending upon the final destination of the meat, the hazard could pose a serious risk for introduction of FMD.

The simplest option for risk management in this case would clearly be to prohibit the importation. However, this would not facilitate trade and might, particularly if the importing country was itself not free of FMD, be considered as an unfair barrier to trade and lead to complaints by the exporting authority to WTO and even to retaliatory measures that might impact negatively on other sectors of the economy. An alternative might be to stipulate that the meat should be deboned and lymph nodes removed in an approved processing facility.

HACCP

An alternative approach to risk identification, assessment and management has been developed to ensure food safety. This system is known as HACCP (hazard analysis and critical control points). As summarised in the EC Regulation No 852/2004 on the hygiene of foodstuffs, the system involves the following requirements:

- identify any hazards that must be prevented, eliminated or reduced to acceptable levels;
- identify the critical control points at the step or steps at which control is essential;
- establish critical limits beyond which intervention is necessary;

- establish and implement effective monitoring procedures at critical control points;
- establish corrective actions when monitoring indicates that a critical control point is not under control;
- implement own-check procedures to verify whether the measures adopted are working effectively;
- keep records to demonstrate the effective application of these measures and to facilitate official controls by the competent authority.

There are many ways in which this system could be advantageously applied to animal disease control measures. For example, the FAO has recently (2011) published a manual that describes a value chain approach to identifying animal health risks, recognising the continuum in animal production from the farm of origin to the final products derived from the animal. This could most effectively be achieved by applying HACCP throughout the value chain. To a large extent the systems in place in the poultry industry in various countries to reduce infection with highly pathogenic and zoonotic salmonellae are based on a value chain approach, with monitoring starting in the flocks at the production site and continuing to production of the final product.

Contingency planning

To enable preparedness for disease emergencies (dealt with in Module 2), contingency plans should be in place before an emergency arises, so that they can be implemented as soon as the alarm is raised. A contingency plan should cover all aspects of dealing with an emergency caused by an outbreak of the particular disease, including actions to be taken before, during, and after the disease emergency.

The OIE recommends that countries develop contingency plans for all the important transboundary diseases, whether or not they have been recently present in the country. However, circumstances exist under which an emergency will be caused by a disease for which no contingency plan has been drawn up. In the case of a disease never having been present in the country or region, it is improbable that it would be prioritised for the development of a contingency plan, although recent experiences of unexpected introduction of diseases into new areas (for example the introduction of classical swine fever into South Africa in 2005, bluetongue into northern Europe in 2006 and African swine fever into eastern Europe in 2007) suggest that contingency plans should be drawn up at least for all highly contagious diseases. There is also the case where the disease emergency is caused by a new, emerging pathogen (examples are BSE, PRRS in pigs, highly pathogenic H5N1 avian influenza in domestic poultry, and Schmallenberg virus), for which there could be no advance contingency plan. In this case, it may be helpful to decide which of the existing contingency plans would be most applicable, and to adjust the actions as necessary.

After an introductory chapter describing the disease, the contingency plan should contain the following elements:

- Description of the Early Warning system based on the following elements:

- Community awareness (describe how this is being put in place)
- Surveillance for the disease (active/passive)
- How field and laboratory diagnosis are assured

- Description of the elements of Rapid Reaction
  - Refer to the legislation in place for emergency disease control
  - Describe the resources available (people, material, money)
  - Describe how rapid deployment will be achieved with the minimum of bureaucratic delays
- Description of how the measures will be implemented. Based on the different farming systems and situations present in the country, the contingency plan should present alternatives, for example approaches that will be used for commercial farming units as opposed to traditional sector farming. It is necessary to identify what can go wrong and to make provision for this in the contingency plan.
- Description of the plan of action for recovery after a crisis, which will include:
  - The policy for re-stocking
  - The source of the stock
  - The strategy to prevent repetition of the crisis

The Food & Agriculture Organization of the United Nations (FAO) provides guidelines and models for contingency plans, but it is recommended that each veterinary service adapts those models to suit their own circumstances. The FAO/EMPRES manual on Good Emergency Practice provides a simple summary of how to prepare a contingency plan, and there is also a model of an aquatic animal disease contingency plan that can be adapted to suit terrestrial conditions and is recommended for use by developing countries. A contingency plan must be realistic and take into account not only local conditions, but "worst case" local conditions. For example, stockpiling emergency vaccine supplies in the area of highest risk might be a good idea in theory, but if that area has a hot climate and an erratic electricity supply subject to lengthy interruptions, and maintaining the cold chain depends upon an electric refrigerator, this option should not even be considered in the contingency plan. Instead, arrangements should be in place to obtain vaccines rapidly from safe stockpiles such as those maintained by reference laboratories and vaccine producers. Contingency plans should be updated regularly as conditions change or experience demonstrates weaknesses in the plan. They are dynamic documents and can be used as the basis of simulation exercises.

Modelling

Mathematical modelling is increasingly being used to predict outcomes of disease events, plan interventions and also to evaluate the effectiveness of the interventions compared with other options once the event is over. A detailed exploration of modelling is beyond the scope of this module but a brief introduction to modelling as a tool for animal health management is necessary. More detailed but easy-to-follow descriptions are available, for example in the excellent textbook on veterinary epidemiology by Thrusfield (see reference list).

The spread of infection in a population can be represented by a simple model, the SIR (susceptible-infectious-recovered) model, in which the rate of spread of infection is expressed as the basic reproductive number, R0. R0 represents the number of cases that will result from contact with a single infected individual. It depends on the infectivity of the agent and the size and density of the susceptible population, as well as the rate at which the infected individual moves through the susceptible population. If R0 is greater than 1 (i.e. more than one secondary infection results from contact with the primary case), an epidemic may occur and can be predicted with confidence at R0 of 2 or more. Epidemics can be self-limiting because as individuals are removed from the susceptible population through recovery or death R0 decreases and when it becomes less than one the epidemic will fade out. If R0 stabilises as 1 the infection can become endemic in the population.

Models may be deterministic, i.e. the parameters are fixed, or stochastic, allowing alternative assumptions to be tested by the model. Stochastic models are used to determine strategies to prevent spread in epidemics or to evaluate whether a control strategy that was implemented was the best one in terms of effectiveness/cost-effectiveness because they allow different alternatives to be evaluated using a single model.

Models are useful tools but they are not infallible and the accuracy of their predictions depends heavily on the correctness of the assumptions on which they are based. For example, a model developed to determine the best strategy to stop the 2001 FMD epidemic in UK assumed that infected individuals would move through the susceptible population at a slow and steady rate in a radial pattern from a focus, whereas in fact infected individuals were moved rapidly over long distances by motorised transport and infected populations not considered to be at risk. Early models for human infection assumed a steady rate without taking into consideration preferential contacts. For animal diseases herd-to-herd contact is often of particular interest and models that allow risk mapping for this can be developed.

TOOLS FOR INTERVENTIONS FOR PREVENTION AND CONTROL

Vaccination

Vaccination is one of the most important tools in the control of the majority of infectious diseases. The global eradication of rinderpest would not have been possible without a highly effective and affordable vaccine. Vaccines are available for the majority of infectious diseases of livestock, with some notable exceptions, for example ASF, malignant catarrhal fever and trypanosomosis.

A good vaccine should achieve reliable and long-lasting protective immunity and be safe in terms of not causing disease or harmful side effects and, in the case of live modified vaccines, not reverting to virulence or mutating to more virulent forms of the agent. The less demanding a vaccine's cold chain requirements are, the more useful it will be in tropical countries where most of the infectious diseases are found. Affordability is also important, whether it is to be used by governments in official control programmes or by farmers. Vaccines that reduce the clinical manifestation of the disease but permit circulation of the virus can be useful in limiting economic losses but can be counter-productive for eradication. Fear that this will happen is one of the reasons why vaccination is forbidden when epidemic diseases are introduced into countries where they have been eradicated or have never occurred. Another reason why vaccination may be forbidden, particularly in exporting countries, is the problem of distinguishing between vaccinated and naturally infected animals. This problem is being or has been addressed for many diseases by the development of DIVA (distinguishing infected from vaccinated animals) technology. This may involve marker vaccines like the subunit vaccine developed for classical swine fever, which is distinguished by an accompanying diagnostic test, or, in the case of FMD, a diagnostic test that identifies non-structural proteins that are not present in the vaccine. However, approaches like that of the EU, which forbids the use of vaccination to control exotic diseases when they appear in member countries, are counter-productive because commercial companies are reluctant to invest in developing vaccines that have no market in countries that can afford them. This may change with increasing resistance to massive culling as the only method to control outbreaks, since it is appreciated that massive culling causes unacceptable suffering for humans and animals and is environmentally highly questionable, particularly when small countries have to dispose of large numbers of animal carcasses.

Vaccination against brucellosis, Mozambique (photograph courtesy of Anabela Manhiça: Mozambique Institute for Agricultural Research)

Many vaccines fall far short of the ideal characteristics listed above. Live vaccines usually provide more durable protection but there are sometimes fears of reversion or mutation to virulence. Outbreaks of Newcastle disease in Australia after an absence of many years were found to involve a virus derived from a vaccine strain that had been used in the affected area. It may also not be advisable to use certain live vaccines in pregnant animals. Killed vaccines are generally safe but protection may not be durable so that re-vaccination at intervals of 6 months or even less may be required, which is often not practical, especially in scattered livestock populations in remote areas in developing countries. Relatively few vaccines are thermotolerant; most vaccines are fragile and require that the cold chain be maintained either from manufacture or, in the case of freeze-dried vaccines, reconstitution to administration to the animal. Even so-called thermostable vaccines will usually not withstand prolonged storage at high temperatures. Vaccine efficacy also depends on the variability of the pathogen; the more variants there are of the pathogen (e.g. FMD, African horse sickness, bluetongue, PRRS), the more likely it is that cross-protection will not occur among all the variants, and it will be important to provide vaccines that will be protective against the variants that circulate in the target area, which is of course not always known or predictable. Antigenic variability is a major reason why there is no vaccine against trypanosomosis. There are also ongoing efforts to develop new generation vaccines for other protozoal diseases (e.g. anaplasmosis, babesiosis, ehrlichiosis and theileriosis) to replace the current vaccines, some of which (e.g. bovine babesiosis, heartwater) are based on infection and treatment. Finally, to be effective vaccines must be administered correctly and this requires training and commitment.

Vaccination for controlled diseases is usually a function of government. Vaccination campaigns need careful planning and management. The procurement process for vaccines should ensure that they are delivered well in advance of their expiry date, in a way that will ensure maintenance of the cold chain. They should be stored in such a way that the recommended temperature is reliably maintained. Arrangements must be made to ensure that the vaccines can be kept cold throughout the distribution and administration process. Vaccines that have spent a hot day in an uninsulated container on the back of a vehicle in the sun are not likely to be effective and the whole effort will have been wasted.

In countries where it is permitted, one option in an outbreak of epidemic disease is to limit the number of animals that have to be slaughtered by some form of emergency vaccination to contain the disease, usually by ring vaccination around the affected focus or foci. In order to regain disease free status, it has been recommended that the animals that were vaccinated should be slaughtered to eliminate them from the population, but the necessity for this is open to question, particularly if the technology to distinguish vaccinated from infected animals is available. When stamping out is not an option, for example in the case of rare zoological collections that are not infected, selective vaccination may be permitted. Vaccination of the total population has also been used as an alternative to stamping out, for example in some HPAI-infected countries where it was deemed impossible to achieve the requisite level of stamping out in backyard flocks.

Chemotherapy/chemoprophylaxis

Dipping cattle

Treating pigs against external and internal parasites

Most bacterial and parasitic diseases of livestock are susceptible to treatment with suitable medicines. Prophylactic treatment for macroparasitic and protozoal diseases is widespread and generally effective, although there are increasing concerns that environmental pollution with anthelmintics and ectoparasiticides may have severe effects on harmless and beneficial invertebrates like dung beetles. There are also increasing problems with the development of resistance among the target parasites, and holistic control strategies that do not depend entirely on chemotherapy are recommended. These include strategies that limit chemotherapy to the animals that need it most, for example the FAMACHA® system that enables the identification of the most anaemic animals to treat for haemonchosis. The principle can also be applied to treatment with trypanocides, since affected animals usually belong to resource-poor farmers. The control of tick-borne diseases in endemic areas should be aimed at maintaining endemic stability by allowing a low level of tick infestation that will ensure continuous exposure of the animals to the pathogen to maintain immunity. Effective drugs are available to treat diseases caused by blood parasites, some of which have a prophylactic effect as well.

Most of the major transboundary diseases of animals are caused by viruses and are therefore not susceptible to chemotherapy. Chemotherapy has been suggested as part of control strategies for contagious bovine pleuropneumonia in endemic areas although, since the OIE has targeted this disease for eradication, the approach may not be popular.

Since therapeutic treatment of large numbers of animals for bacterial diseases may not be practical, the use of antimicrobials in feed, sometimes at sub-therapeutic doses, to control infectious diseases and thereby promote growth has been widespread in intensively farmed animals. It is now being discouraged because of fears of the development of antimicrobial resistance that will make the medicines ineffective and also fears of levels remaining in the animals at slaughter that could lead to resistance in humans. The danger of antimicrobial residues in food animals to humans has not been quantified, but widespread use of antimicrobials in agriculture is promoted as the greatest risk for human health. Human misuse of antimicrobials, which is known to be widespread, is less popular as a potential cause of resistance. The danger of veterinary drug usage is likely overrated, but prolonged use of in-feed medication could certainly promote resistance and render some drugs useless in controlling disease outbreaks. It is therefore strongly recommended that prophylactic medication should be of short duration for particular diseases – pulsed medication – and/or reserved for therapy when necessary. This is referred to as the rational use of drugs.

The provision of treatment and clinical services by government veterinarians when this is not linked to official control programmes is a matter for debate. In countries where no or very limited private veterinary services are available, or where a large proportion of the livestock producers are subsistence farmers who cannot afford private services, interventions by government veterinarians may be necessary. There is no doubt that the provision of primary animal health care enhances the image of state veterinarians and creates an opportunity to improve disease surveillance. Various attempts have been made to distinguish between “public” and “private” goods in the provision of veterinary services, the former involving animal diseases that are a threat to public health or the national economy, for example highly contagious diseases and/or zoonoses, while the latter refers to diseases that are in the farmer’s own interests to control. Greater private sector involvement has been advocated, but the practicality of this will of course depend upon the availability of private veterinary service providers as well as the ability and willingness of livestock producers to pay for the services. The provision of primary animal health care by trained community animal health workers (CAHWs) is an option that has proved beneficial when properly managed.

Biosecurity

The underlying principle of biosecurity is protection from harm caused by hazards of biological origin. A very broad definition is “The protection of the environment, economy and health of living things from diseases, pests, and bioterrorism” (Encarta 2009). The biological hazards may be restricted to pathogenic micro-organisms or may include all possible hazards including introduction of alien plants and animals, genetically modified organisms and new molecules. In the veterinary context, four issues have been identified as important:

- Protection of human and animal health from hazards posed by food of animal origin
- Protection of human and animal health from hazards posed by international trade in animals and animal products
- Protection of human and animal health by implementing an adequate level of biosecurity in veterinary laboratories and animal facilities

- Protection of human and animal health in emergency situations involving animals, with particular emphasis on animal disease outbreaks

The application of biosecurity measures in the production unit is of cardinal importance to ensure that only healthy animals leave the farm. Essentially, on farm biosecurity means the construction of barriers between the animal and the pathogen. These barriers may be physical, e.g. buildings and screens to exclude vectors; chemical, e.g. disinfectants and prophylactic medicines and pesticides; or biological, e.g. vaccines. The nature of the barriers and how they are implemented depends on the species and the farming system. Stringent biosecurity measures such as showering in and out of the facility and vector exclusion can be applied only in indoor systems such as intensive commercial pig and poultry units.

Measures used to prevent pathogens from being brought into a herd from outside sources (external biosecurity measures) include:

- Restricted access to the premises where the animals are kept
- Hygienic measures to ensure that people who need to enter the premises do not bring in pathogens and strict control/decontamination of materials brought onto the farm
- Keeping a closed herd
- Introduction of animals only from herds of known health status
- Quarantine of newly introduced animals
- Legal requirements for a minimum distance between farms
- Measures to keep out rodents, birds, carnivores, other livestock; strict separation between domestic livestock and wildlife
- Strict control over feed; no swill feeding; ensuring that feed and feed sources are wholesome and free from contaminants from manufacture through delivery and storage to consumption
- Exclusion of vectors (e.g. insect-proof stables, barns)

Accredited pig farm, Limpopo Province, South Africa

It is evident that some of the measures are more practical and easy to implement than others, depending on the animals and how they are kept. More details are available in the **modules on biosecurity**.

Segregation of populations

The creation of zones free of specific diseases by separating susceptible populations of animals from potential sources of infection has for a long time been used to underpin trade in livestock and livestock products. Traditionally two categories of freedom from disease were recognized: country freedom and zonal freedom.

The OIE recognises geographical zones that are free for two diseases: FMD and CBPP; until its global eradication was announced in June 2011 geographical zones free from rinderpest were also officially recognized. In the case of BSE, recognizing that freedom cannot be proven in the same way as it is for the other diseases, countries can apply to be classified as posing a low or negligible risk for BSE. In some SADC countries zonal freedom from FMD without vaccination has been achieved by using fences to effect physical separation between African buffalo and domestic livestock combined with buffer zones with vaccination and observation. The principle that a zone can be free of a specific disease with vaccination is accepted and is applied in Brazil, but to achieve freedom with vaccination it is necessary to be able to distinguish between vaccinated and unvaccinated animals. This is currently difficult for FMD within the SADC region, since the test used to distinguish between vaccinated and infected animals is regarded as insufficiently sensitive for the SAT virus types; however, this situation is changing by the use of purified antigen in the vaccines so that detection of non-structural proteins is very unlikely to indicate anything other than natural infection.

It has been accepted by the OIE that for certain diseases it will be virtually impossible to achieve geographically free zones, for example Newcastle disease and avian influenza. A "new" concept, compartmentalisation, has been proposed, in which a production unit may declare itself free of one or more specific diseases, allowing export of livestock commodities originating from that unit to take place provided the veterinary authority and trading partners accept the status. The concept is based on strict biosecurity of the unit, which applies also to the feed source, transportation of animals for slaughter, and the slaughter facility. The OIE does not officially recognise compartments but the competent authority in countries may recognise them for purposes of certification. It is recognised that the control measures that countries like Kenya and South Africa adopted for pig farms not long after ASF was identified as a disease entity in the first half of the last century effectively resulted in compartmentalisation of pig farms for wildlife-associated ASF. The requirements for zoning and guidelines for compartmentalisation are provided in the Terrestrial Animal Health Code (Chapters 4.3 and 4.4) available on the OIE website.

Commodity-based trade

Recognising that it may be difficult if not impossible for many developing countries with endemic transboundary diseases to achieve country or zonal freedom in the short term and that compartmentalisation is largely applicable to intensive production units like commercial piggeries and poultry farms where a high level of biosecurity can be achieved and maintained, another approach has been proposed. This approach, referred to as commodity-based trade (Thomson *et al.* 2004), is based on the fact that certain commodities are inherently safe even if, by an unfortunate chance, they originated from an infected animal. For example, de-boned matured beef from which the lymph nodes have been removed is unable to harbour FMD virus owing to the low pH reached during maturation (Thomson *et al.* 2009). A number of cured pork products including Parma and Serrano ham have been demonstrated to be unable to harbour ASF and CSF, as well as FMD viruses, owing to the lengthy process of curing. The OIE has adopted the concept provided that sufficient assurances can be given in terms of product safety on the basis of scientific evidence.

The acceptance of compartmentalisation and commodity-based trade is in line with Article 4 of the SPS Agreement of the WTO which permits export from countries that are not free of certain diseases provided that they can satisfactorily demonstrate that the commodities pose no more than an acceptable level of risk. In practical terms, this means that the commodities should originate from an area or compartment that is free of the specified disease/s, or should be demonstrably unable to transmit the specified infectious agent/s. In line with this, the OIE has also relaxed its requirement for livestock and commodities for export to originate from a geographical area that is free of FMD in terms of Chapter 8.5 Article 8.5.25, which lists the conditions under which fresh meat of cattle and water buffaloes can be exported from FMD infected countries or zones that have an official control programme for FMD involving compulsory systematic vaccination of cattle. Unfortunately, higher priced markets such as the EU have so far refused to accept anything but geographical freedom. The EU does not even accept the official OIE recognition of zones free of FMD, conducting their own inspections before agreeing that the zones are likely to be free of FMD.

The use of veterinary cordon fences to separate livestock from wildlife populations in order to prevent diseases, usually FMD, is controversial. It has enabled some southern African countries to achieve recognition of zones free of FMD and consequently to be able to access higher priced markets for beef, like the EU. However, the erection of these game-proof fences disrupts game migration routes and has often had devastating effects on wildlife. The establishment of transfrontier conservation areas (TFCAs) like the Great Limpopo and Kavango-Zambezi TFCAs requires removal of fences in order to allow game to move freely. This means that new ways have to be found to manage animal diseases at the livestock/wildlife interface. More information about fences and biodiversity is available on the AHEAD website (http://www.wcs-ahead.org/documents/asthefencescomedown.pdf).

Fences are used to separate African buffalos and cattle (photograph courtesy of Dr Dewald Keet, specialist wildlife veterinarian)

Fences have undesirable effects on wildlife (photograph courtesy of Dr Dewald Keet, specialist wildlife veterinarian)

Animal identification and traceability

The issue of animal identification and traceability is linked to livestock marketing systems. Traceability also supports animal health management by enabling better follow-up during outbreaks as well as proper registration of animals during interventions such as vaccination campaigns and surveillance for diseases. However, the demand for traceability throughout the marketing chain by trading partners in industrialised countries may require resources that are simply not available. It is usually the responsibility of the animal health authorities to decide which systems are appropriate to their situation (for example individual animal identification vs herd or batch identification) and whether a large investment in identification will be justified in terms of the expected financial gains through trade. There are obvious advantages to the producers in identifying their animals, for example increasing the possibility of recovering stolen livestock. DNA databases containing the profiles of high value breeding stock like racehorses and bulls enable parentage to be assured. This has been extended in recent years to rhinoceroses and other valuable wildlife and the information can be implemented in cases of poaching.

Natural resistance

The introduction of European breeds of cattle into Africa highlighted the fact that local cattle breeds, in particular certain breeds, were more resistant to the local diseases like East Coast fever and trypanosomosis than the introduced cattle. The concept of using genetic resistance to control animal diseases is attractive and research into the genetics of disease resistance is ongoing, although so far not very much progress has been made. The evolution of natural resistance requires lengthy periods of time. For example, natural resistance to trypanosomosis in N'Dama and Boran cattle is likely to be due to the fact that these breeds have been in Africa for a very long time and may have evolved on the continent. Modern genetic technology enables the identification of markers for genetic resistance to disease, but selection for those markers is firstly a slow process and secondly may result in selection for other characteristics that are less desirable. However, the potential exists and in the end genetic resistance may be able to make some contribution to solving the problems of antimicrobial resistance and environmental pollution as a result of chemoprophylaxis.

Angoni cattle, with some resistance to ticks: Tete Province, Mozambique

TOOLS FOR DEALING WITH A DISEASE EMERGENCY

Quarantine

When a serious infectious disease is suspected in a population of animals, the area or premises is usually quarantined pending confirmation of the disease in order to prevent spread. The area may be a farm, a district or a larger area, depending on the time lapse between discovery of the disease and its initiation, as well as the density and distribution of the susceptible animal population and the level of contact within and between herds or flocks. The way in which the disease is transmitted also influences the size of the area that will need to be quarantined. Fortunately, warm dry climates do not favour aerosol transmission of pathogens, so this is generally not an important consideration in sub-Saharan Africa. If a single farm is involved the farmer is usually served with a quarantine order that requires him/her not to move any animals or their products off the premises; other restrictions may be required depending on the disease and the circumstances. When larger areas are quarantined, road blocks are usually put in place to prevent movement out of the area. This often requires the participation of law enforcement agencies like the police or the army, unless the veterinary services have sufficient resources to maintain the roadblocks, which have to operate 24 hours a day in order to be effective.

If laboratory testing does not confirm the suspicion of the disease, the quarantine is lifted. If disease is confirmed, the quarantine will be maintained until further steps towards control have been taken or, in the case of mild disease without a carrier state, the disease has run its course and no further infections are expected. This was the case with pig herds that were infected with the novel pandemic H1N1 virus (incorrectly called ‘swine ‘flu’) in 2009, when they were infected by workers with active disease. However, most often the animals are likely to be destroyed unless there are circumstances that make that impractical as discussed below.

Movement control

Movement control is not only an emergency disease control measure. In many countries movement control is routinely applied, for example to animals being moved to abattoirs for slaughter, in order to prevent illegal movements of animals that may, for example, have been introduced illegally from another country or from an infected area in the same country. The law may make provision for movement control of particular species, for example buffaloes or wildebeest (gnu), because they are known to be reservoirs of diseases that can affect livestock. Movement of pigs from accredited farms in the ASF control area in South Africa, as well as movement of warthogs, is subject to veterinary permits, as is movement of all cloven-hoofed animals from the area around the Kruger National Park and currently from a wider area since Soth Africa lost its FMD-free status after the outbreaks in KwaZulu-Natal in 2011.

When there is an outbreak of a highly infectious or trade-sensitive disease, movement control may be more rigorously applied and, as indicated above, may involve the police and even the army, as occurred during the Type O FMD outbreak in KwaZulu-Natal in 2000. Although it is an important and necessary measure, movement control is far from infallible, as animal movement is not always restricted to main roads or to roads at all, and animal products are relatively easily concealed. Careful examination of all vehicles may be impractical along roads with heavy traffic. The effectiveness of road blocks also depends on the commitment of the people manning them. During the first ASF outbreaks in Benin in 1997/1998 the rate of recovery of pigs and pork at road blocks increased remarkably when meat traders, who were out of business and annoyed about it, became involved in the road blocks and were serious about searching for pork. The fate of animals and their derivatives confiscated at road blocks also needs to be carefully controlled to ensure that they are not illegally traded.

Stamping out (culling)

Culling, or stamping out, of infected animal populations is a traditional way of eradicating a disease outbreak as quickly and effectively as possible. Countries that wish to regain FMD-free status after an outbreak in a free zone can do so much more rapidly if stamping out is used as opposed to other less drastic approaches, like vaccination. However, there are various circumstances that can make culling less effective, and can even result in enhanced spread of the disease. Circumstances that can lead to the disease being widespread with multiple foci include late diagnosis, bureaucratic delays in implementation of control measures, and logistically difficult areas, e.g. mountainous or flooded areas. The issue of compensation has a strong influence on the effectiveness of culling. Compensation that is not market related, or no compensation, are likely to result in disobedience and animals being concealed or illegally moved, while compensation that is too generous may lead to dishonesty, as was reported to have happened during the FMD outbreaks in the United Kingdom in 2001. Even when the ‘price is right’, as was the case in Botswana when 320,000 cattle were killed during the CBPP outbreak and during the 2005 CSF outbreak in South Africa, animal owners do not like to have their animals killed and, while cattle are difficult to conceal, concealment of pigs in the Eastern Cape Province was reported to occur.

Before embarking on massive culling, disposal of the carcasses has to be carefully planned. There are concerns about both environmental pollution, as was reported when thousands of cattle and pigs were culled to eradicate an outbreak of FMD in Korea in 2010 and rivers became polluted, and about spread of infection owing to access to the sites by poor people to whom the destruction of meat is incomprehensible.

Massive culling as a way to eradicate outbreaks is increasingly being questioned. The sight of piles of carcasses being burned in the UK as a result of culling for both BSE and FMD caused public outrage, as did the situation in South Korea, where animals were reported to have buried alive. Disposal of carcasses is likely to become more and more of a challenge in an increasingly densely populated world, and the psychological effects of this approach on animal owners also need to be considered. The latter was highlighted by the fact that some affected farmers in the UK in 2001 committed suicide. There are therefore ongoing initiatives to find alternative but effective ways of controlling animal disease outbreaks. These place an emphasis on vaccination as well on much more rigorous preventive measures so that outbreaks can be avoided as far as possible. Sometimes it is recognised that culling is not the right approach; massive culling is usually not even attempted in poor countries if there are insufficient resources to compensate the farmers. The authorities will at most attempt modified stamping out, where only infected animals are killed and those that escape infection or recover are allowed to live. This approach was to an extent used in Mauritius during the 2007 ASF outbreak, which was nevertheless eradicated by 2008. It is likely that in spite of the fact that massive culling is still recommended as a control measure, its acceptability will be increasingly questioned on the grounds of animal, human and environmental welfare, with a growing need to take cognizance of considerations like environmental pollution and the destruction of large amounts of edible protein in a hungry world.

FAQS

1. **What does the term surveillance for animal diseases mean?**

   It means the gathering and analysis of information about the status of animal health in a given population (e.g. the national cattle herd or all livestock in a defined area) and the dissemination of that information to support disease control interventions and prevent disease emergencies.

2. **What is the difference between monitoring and surveillance as applied to animal health?**

   While surveillance is an ongoing activity, monitoring involves periodic specific actions e.g. observation, sampling, taking of routine measurements, to identify any changes in the environment or health status of an animal population or any changes in the status of a particular animal disease.

3. **What is participatory disease surveillance?**

   It is a technique to obtain information about animal diseases from rural livestock owners who may not be highly educated or able to read, using a process of interaction that enables them to describe or portray what they have observed in their herds or flocks in a way that is understandable to the people who are gathering the information.

4. **Who is responsible for animal disease surveillance?**

   The government veterinary services are responsible for animal disease surveillance in terms of gathering, collating and analysing the information, but disease surveillance at local level is the responsibility of everyone who is involved with animals, including livestock owners and non-veterinary professionals who work with animals.

5. **Why is it necessary to confirm the diagnosis of an animal disease by sending samples to a laboratory even if you can recognise the disease by its symptoms?**

   Although many diseases can be recognised by the way they present in the animal, laboratory confirmation is highly recommended and usually mandatory before resources are invested in controlling the disease; in the case of animal diseases that affect trade it would be foolish to court trade bans without certain confirmation that the disease is present. Even at farm level some form of confirmation, even if only blood smear examination, is advisable to ensure that whatever the farmer pays for is likely to work.

6. **What does 'One Health' mean in terms of animal health management?**

   Since 'One Health' refers to the interrelationship between human, animal and environmental health, the responsibility of the animal health manager is not only to manage animal health by controlling animal diseases, but to do this in a way that is not harmful and if possible is beneficial to human health and the environment as well. This means understanding the issues involved and interacting with practitioners involved in human and environmental health management to ensure the best outcomes of animal health interventions.

7. **Why is the massive culling of animals still the method of choice to control animal disease epidemics when it has received so much negative publicity?**

   Alternative ways of controlling animal disease epidemics are increasingly being explored and questions are being raised about why vaccination is not used instead of massive culling. Progress has been made to the extent that at least for diseases that are not susceptible to eradication, like bluetongue, influential bodies like the EU have accepted that vaccination is the only viable approach. However, fears that unless eradication by stamping out is applied the disease will become endemic and trade restrictions have hampered the application of less drastic measures. Another contributing factor is the inability to distinguish in all cases between vaccinated and naturally infected animals. In the end, the impossibility of disposing of very large numbers of animals that have been killed and the cost of compensating their owners, as well as availability of marker vaccines (i.e. vaccines that enable distinction between vaccinated and infected animals) for an increasing number of diseases will most likely provide the necessary impetus for a change of approach.

8. **What are the problems about using vaccination to control epidemics?**

   Briefly, the main problem is that vaccination needs to be done before animals are infected and immunity takes some time, usually about 14 days to develop, so it can be used to prevent spread by protecting the animals at risk but not yet affected, but not to 'cure' the animals that are already infected. Other problems are that many vaccines prevent clinical disease but not infection; that some types of vaccines cannot be used in certain classes of animals, e.g. pregnant and very young animals; and trade-related issues mainly resulting from inability to distinguish between vaccinated and infected animals. Technology has been developed to enable antibodies resulting from vaccination to be distinguished from those elicited by natural infection ('DIVA' technology), and so-called marker vaccines are becoming available for an increasing number of diseases, Including FMD, CSF and Aujuszky's disease.

9. How is biosecurity applied on farms?

The level of biosecurity measures applied depends on the type of farming operation and the level of assurance required, as well as the disease threats from which protection is needed. At its simplest level, for instance on small farms targeting local markets, biosecurity measures may consist of confining the animals, restricting access to the animals, disinfection of footwear of people who do need access, and hygienic measures to prevent build-up of pathogens. At the other end of the spectrum are farms using compartmentalisation to target export markets, with measures that include showering in with a complete change of clothing, regular sampling of feed and water to ensure that they are not contaminated with pathogens, and an auditing system to demonstrate compliance with all the biosecurity requirements.

10. What is a disease free zone?

A 'disease free zone' is an area that can be demonstrated to be free of one or more specified animal diseases (obviously it would be impossible to have zones that could be proven to have no diseases at all!). The term implies that the zone is free not only of the disease but also of the infection, i.e. the pathogen that causes the disease is not present in the zone.

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   Chapter 3.2 Evaluation of veterinary services
   Chapter 3.3 Communication
   Chapter 4.1 General principles on identification and traceability of animals
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