PREPARATION
OF FOOT-AND-MOUTH DISEASE
CONTINGENCY PLANS

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This manual is based on the format of the Australian Veterinary Emergency Plan (AUSVETPLAN) with modifications.

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### Acronyms and abbreviations

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>ACIAR</td>
<td>Australian Centre for International Agricultural Research</td>
</tr>
<tr>
<td>APHCA</td>
<td>Animal Production and Health Commission for Asia and the Pacific</td>
</tr>
<tr>
<td>ASEAN</td>
<td>Association of Southeast Asian Nations</td>
</tr>
<tr>
<td>AU</td>
<td>African Union (see OAU)</td>
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<tr>
<td>AUSVETPLAN</td>
<td>Australian Veterinary Emergency Plan</td>
</tr>
<tr>
<td>CCEAD</td>
<td>Consultative Committee on Emergency Animal Diseases</td>
</tr>
<tr>
<td>CFT</td>
<td>complement fixation test</td>
</tr>
<tr>
<td>CVO</td>
<td>chief veterinary officer</td>
</tr>
<tr>
<td>DVS</td>
<td>Director of Veterinary Services</td>
</tr>
<tr>
<td>ECOWAS</td>
<td>Economic Community of West African States</td>
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<tr>
<td>ELISA</td>
<td>enzyme linked immunosorbent assay</td>
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<tr>
<td>EMC</td>
<td>encephalomyocarditis</td>
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<tr>
<td>EMPRES</td>
<td>Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases</td>
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<tr>
<td>EU</td>
<td>European Union</td>
</tr>
<tr>
<td>EUFMD</td>
<td>European Commission for the Control of Foot-and-Mouth Disease</td>
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<tr>
<td>FAO</td>
<td>Food and Agriculture Organization of the United Nations</td>
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<tr>
<td>FMD</td>
<td>foot-and-mouth disease</td>
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<tr>
<td>FVO</td>
<td>field veterinary officer</td>
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<tr>
<td>IATA</td>
<td>International Air Transport Association</td>
</tr>
<tr>
<td>IBAR</td>
<td>Interafrican Bureau for Animal Resources</td>
</tr>
<tr>
<td>IETS</td>
<td>International Embryo Transfer Society</td>
</tr>
<tr>
<td>NGO</td>
<td>non-governmental organization</td>
</tr>
<tr>
<td>NSP</td>
<td>non-structural proteins</td>
</tr>
<tr>
<td>OAU</td>
<td>Organization of African Unity (superseded by AU)</td>
</tr>
<tr>
<td>OIE</td>
<td>International Office of Epizootics/Office International des Epizooties</td>
</tr>
<tr>
<td>OP</td>
<td>oesophageal-pharyngeal (probang)</td>
</tr>
<tr>
<td>Panafotsa</td>
<td>Pan American Foot-and-Mouth Disease Center</td>
</tr>
<tr>
<td>PCR</td>
<td>polymerase chain reaction</td>
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<tr>
<td>Abbreviation</td>
<td>Full Form</td>
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<td>--------------</td>
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<tr>
<td>ProMED</td>
<td>Program for Monitoring Emerging Diseases</td>
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<tr>
<td>PVO</td>
<td>provincial veterinary officer</td>
</tr>
<tr>
<td>RNA</td>
<td>ribonucleic acid</td>
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<tr>
<td>SADC</td>
<td>Southern African Development Community</td>
</tr>
<tr>
<td>SEAFMD</td>
<td>Southeast Asian Foot-and-Mouth Disease Campaign</td>
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<tr>
<td>TAD</td>
<td>transboundary animal disease</td>
</tr>
<tr>
<td>TADinfo</td>
<td>Transboundary Animal Diseases Information System</td>
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<tr>
<td>VNT</td>
<td>virus neutralization test</td>
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Foot-and-mouth disease (FMD) is one of the most serious transboundary animal diseases. It is a highly contagious viral disease, and may have rapid and unanticipated national and international spread. Although not a very lethal disease for adult animals, it can cause crippling socio-economic consequences, through high production and trade losses.

Transboundary animal diseases (TADs) for the Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases (EMPRES) are those diseases that are of significant economic, trade and/or food security importance for a considerable number of countries; which can easily spread to other countries and reach epidemic proportions; and where control/management, including exclusion, requires cooperation among several countries. The International Office of Epizootics (OIE) International Animal Health Code includes FMD in List A diseases, defined as “communicable diseases which have the potential for serious and rapid spread, irrespective of national borders; which are of serious socio-economic or public health importance; and which are of major importance in the international trade of animals and animal products”.

This manual provides information on the nature of FMD and the principles and strategic options for its prevention, control and elimination. Guidelines are provided for individual countries threatened by FMD to formulate their overall national policy on control and eradication of a possible incursion of the disease. The manual also identifies personnel, equipment and other facilities that are needed in a national FMD contingency plan. An outline of suggested format and contents of a national FMD contingency plan is provided as a guide but should be modified to suit the needs and circumstances of individual countries.

Due consideration was given to the provisions in the OIE International Animal Health Code in the preparation of the manual. It is suggested that the manual be used in conjunction with the *Manual on the preparation of national animal disease emergency preparedness plans* (FAO, 1999a) cited on p. 2.
Sources of information recommended for use with this manual include:


The manual will be reviewed regularly and revised in the light of experience. Suggestions and recommendations for any amendments should be sent to:

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www.fao.org/empres
Chapter 1

Suggested format and contents of a national FMD contingency plan

An FMD contingency plan should be a well-articulated strategy document designed to define actions to be taken in the event of an FMD emergency. It should contain details of the resources needed to meet such an emergency as well as an action plan for efficient and rapid deployment of both human and material resources for effective containment of the disease and elimination of infection. While it is not feasible to produce a model contingency plan that will be a perfect fit for all situations and circumstances in different countries, the suggested format and contents as described below will serve as guidelines for individual countries to design their own national FMD contingency plans. Suggestions for aspects to be included in a national FMD contingency plan are given below.

This component should describe the essential features of FMD such as:
- aetiology
- world evolution and distribution
- epidemiological features
- clinical signs
- pathology
- immunology
- diagnosis: field, differential and laboratory.

Most of these aspects, as described in the manual, are generic while others may need to be modified to reflect the prevailing circumstances in individual countries (e.g. susceptible species and numbers; husbandry and management practices; and structure and resources of veterinary and ancillary services).
This provides information on just how serious a threat FMD is for a country in comparison with other transboundary animal diseases, where and how FMD might be present, and what its potential consequences are. Risk analysis should indicate just how much effort needs to be put into contingency planning, provide the rationale for the disease control strategies selected, and facilitate prioritization of risk management activities.

Risk analyses need to be updated regularly to take account of changing circumstances, both within and outside the country.

Prevention strategies should describe the measures to be taken in order to minimize the risk of introduction and establishment of FMD in the country or in FMD-free areas of the country, taking into account the assessed risks of introduction and the available strategies for reducing these risks through the control of transboundary livestock movements and management of importation of both animal products and waste materials of animal origin.

This includes all the initiatives that need to be taken to ensure both that an incursion of FMD can be recognized and reacted to before it reaches epidemic proportions in the country and also for monitoring the progress of eradication campaigns. The plan includes passive and active disease surveillance and epidemiological capabilities such as emergency disease reporting mechanisms and animal health information systems; training of animal health staff in recognition of the disease; and public awareness programmes.

This component includes the strategies and programmes that need to be implemented first to contain an FMD epidemic and then progressively to control and eradicate it through zoning, quarantine, livestock movement controls, stamping out and/or targeted vaccination campaigns – in a way that minimizes the socio-economic consequences. It also describes how eradication of the disease is to be verified.

The administrative structures of national veterinary services, which have evolved mainly to deal with routine animal health programmes, are not necessarily appropriate for emergency disease control. This component describes the organizational arrangements to be
Put in place when there is an FMD emergency so that all necessary resources are efficiently exploited to respond to the emergency. These arrangements will vary according to the infrastructure, capability of the veterinary services and bureaucratic systems of the country concerned.

**SUPPORT PLANS**
Support plans underpin the technical plans. They include financial and resource plans and legislation. They are of vital importance and are a key to the success or failure of an eradication campaign.

**ACTION PLANS**
These are the mechanisms whereby the various phases of the plan are implemented, from the initial investigation phase to the final stand-down phase.

**APPENDIXES**
A list of names and contact addresses including telephone numbers, fax numbers and e-mail addresses of the following could be placed as appendixes to the contingency plan:
- FMD regional and world reference laboratories
- International organizations offering possible assistance.
Also included may be information on:
- National animal health laws
- Anything specifically relevant to an individual country.

It should be emphasized that the following chapters only provide the framework for countries to develop their own FMD contingency plans, taking their particular circumstances into account. The strategies of different countries for countering FMD will vary considerably according to their veterinary and other infrastructure capacity, the stage of development of their livestock industries, and their potential for export of livestock and livestock products.
Chapter 2

Nature of the disease

**DEFINITION**

FMD is a highly contagious viral vesicular disease of cloven-hoofed animals. Although seldom lethal in adult animals, it causes serious production losses and is a major constraint to international trade in livestock and livestock products. Severe mortality may occur in young stock, particularly lambs and piglets.

**WORLD DISTRIBUTION**

FMD is endemic and at a high prevalence in many countries in Africa, the Middle East and Asia and is also present in parts of South America. Europe, North and Central America, the Pacific nations and the Caribbean are free from the disease.

During the past decade, distribution of the various serotypes has been reported as follows: type O – Asia, parts of Africa and South America, with recent incursions into the United Kingdom and parts of western Europe; type A – Asia, parts of South America and Africa; type Asia 1 – Asia and southeastern Europe; type SAT 1 – Africa and the Arabian Peninsula; type SAT 2 – Africa and the Arabian Peninsula; type SAT 3 – southern Africa; and type C – South Asia and eastern Africa.

The evolution of the pandemic Pan-Asia strain of type O FMD virus in recent years is a good illustration of the disease’s potential for sudden and unanticipated international spread. Since its first identification in northern India in 1990, FMD has spread to Nepal (1993), Saudi Arabia (1994) and thence to most of the Middle East; to Europe (Turkish Eastern Thrace, Bulgaria and Greece) in 1996; Bangladesh (1996); Bhutan (1998); mainland China, Taiwan Province of China, Thailand and Malaysia (1999); the Russian Federation, Mongolia, Republic of Korea, Japan and South Africa (2000); and the United Kingdom, Ireland, France and the Netherlands (2001).

**AETIOLOGY**

The FMD virus is a member of the *Aphthovirus* genus of the family Picornaviridae. The virion is non-enveloped, about 25 nm in diameter, and has an icosahedral symmetry. It contains a molecule
of single-stranded RNA and 60 copies of each of the four structural polypeptides (VP1, VP2, VP3 and VP4). Of these, VP1 contains antigenic determinants that are important in stimulating neutralizing antibodies in infected hosts.

There are seven serotypes of FMD virus – A, O, C, SAT 1, SAT 2, SAT 3 and Asia 1. All the serotypes produce a disease that is clinically indistinguishable but immunologically distinct. There is no cross-immunity among serotypes. They can be differentiated by various serological tests, including the virus neutralization test (VNT), the complement fixation test (CFT) and enzyme linked immunosorbent assay (ELISA). Within each serotype there is a spectrum of antigenic variation with strains of close or distant relationship to each other. Antigenic variation tends to be greatest within type A. Analysis of strains of FMD virus by antigenic and genetic profiles is important in epidemiological studies and for the selection of the most appropriate vaccine strains for a region where vaccination is practised.

The FMD virus is sensitive to both acid and alkaline conditions. It is most stable at pH 7.4-7.6 but all strains are rapidly inactivated below pH 4 and above pH 11. There is some strain variation at intermediate values, but the major determinant is temperature. The virus will retain infectivity at pH 6.7-9.5 at 4°C or lower, but this range narrows as the temperature rises.

The effect of temperature on viral infectivity is influenced by the suspending medium, with organic matter providing some protection against inactivation. At temperatures below freezing, the virus is stable almost indefinitely. Even at 4°C in simple media the virus retains infectivity for more than one year. Suspensions of virus will retain infectivity for eight to ten weeks at ambient temperatures of about 22°C, and for up to ten days at 37°C. Above this temperature, inactivation is more rapid. For example, 56°C for 30 minutes is sufficient to inactivate most strains of FMD virus.

Sunlight per se has little effect on the virus. Environmental inactivation is related more to the effects of desiccation (less than 60 percent relative humidity) and temperature. Acid and alkaline formulations are the most effective for disinfection.

**Susceptible species**

Of the domestic livestock species, cattle, water buffaloes, pigs, sheep, goats and deer are susceptible to FMD; the disease is generally most severe in cattle and pigs. Camelidae (camels,
llamas and vicuñas) have a low susceptibility. Wild cloven-hoofed species are susceptible. Though rare, FMD in elephants, hedgehogs and some rodents has been documented. African buffaloes (*Syncerus caffer*) commonly become infected with FMD virus of the SAT serotypes, although clinical disease is rarely if ever observed.

Some FMD virus strains have a pronounced predilection for one livestock species or another (e.g. pigs or cattle). Such was the case of the porcophillic type O strain circulating in recent years in East Asia.

Human infections have been reported but are extremely rare and mild. However, people may harbour the virus in their respiratory tract for more than 24 hours without ever developing clinical disease.

**Virus survival**

*In the environment.* The FMD virus can retain infectivity for considerable periods in the environment provided it is protected from desiccation, heat and adverse pH conditions. For example, the virus may survive for 14 days in dry faecal material; six months in slurry in winter; 39 days in urine; 28 days on the surface of soil in autumn; and three days on the surface of soil in summer. Such observations have generally been made in countries with a temperate climate, and these times can be expected to be much shorter in countries with hot climates.

*In the host (including pathogenesis of the disease).* The respiratory system is the major route of infection in ruminant species, and very small doses of virus can initiate infection. The respiratory route is also the more usual portal of entry for pigs, but these animals are much more susceptible to infection by the oral route than are ruminants. The virus can also enter through abrasions in the skin or the mucosae as a result of injury caused by damage from grass seeds, feeding on rough fodder, foot rot, trauma from milking machines or from fingernails during nose restraint of cattle.

After inhalation, virus-laden droplets are transported by ciliary action to the pharyngeal area. Following primary multiplication in the pharyngeal mucosa and draining lymph nodes, the virus is transported in the bloodstream to secondary sites that include the glandular organs, other lymph nodes, epithelial tissues in and around the mouth and feet, and the mammary glands in females. The vagina and prepuce may also be involved. Cardiac muscle is a secondary target in young animals.

The virus is excreted in large quantities in expired air, in all
Nature of the disease

secretions and excretions (including milk and semen) and from ruptured vesicles. Pigs liberate vast quantities of airborne virus in their expired breath – about 3,000 times as much as cattle.

Excretion of the FMD virus can begin up to four days before clinical disease becomes apparent, and this is of great epidemiological significance. Most excretion of the virus ceases four to six days after the appearance of vesicles, when circulating antibodies develop. The virus tends to persist in foot lesions for a day or two longer than in mouth lesions, so that foot lesions may be a better source of virus for diagnostic purposes in older cases. The FMD virus has been detected in the milk and semen of experimentally infected cattle for 23 and 56 days respectively.

After clinical recovery, up to 80 percent of ruminant animals may become persistently infected. This situation is termed the “carrier state” and is defined as carriage of the virus beyond 28 days after primary infection. Such persistent infection is established in the pharyngeal and cranial oesophageal tissues. The duration of the carrier state varies with the host species, strain of virus and possible other factors. The maximum reported carrier periods for different species are three and a half years for cattle; nine months for sheep; four months for goats; and five years or more for African buffaloes. The virus can be recovered intermittently from such animals by oesophageal-pharyngeal (OP) probang collections. The quantity and frequency of virus that can be collected decline progressively with time. Deer, antelopes and llamas either fail to become carriers or carry the virus for only short periods. Little is known as to whether there is a carrier state in water buffaloes. Pigs do not become long-term carriers, and cease excreting the virus within three to four weeks of becoming infected.

In animal products. Although the FMD virus is inactivated in the meat of carcasses that undergo the normal post-slaughter acidification processes, it can retain infectivity for very long periods in frozen or chilled lymph nodes, bone marrow and residual blood clots, and for shorter periods in offal. Other products in which the virus can retain infectivity for long periods include uncooked salted and cured meats, green-salted hides, unpasteurized milk and some other dairy products.

Disease transmission
FMD is perhaps the most contagious of animal diseases. Pigs are regarded as important amplifying hosts for the disease because of
their ability to be infected orally and their capacity to excrete large quantities of virus in their exhaled breath. Cattle are regarded as good indicator hosts because of their extreme sensitivity to infection by the respiratory route, and the usual development of severe, classical clinical signs in these animals. Sheep have been thought of as maintenance hosts because infection with some virus strains can spread through flocks with little overt sign of disease. It must be stressed that not all FMD viruses will behave in the same way epidemiologically nor will they all have the same host range.

The disease may be transmitted in many ways, including:

- **Direct contact.** FMD can be readily spread by direct contact between infected and susceptible animals, and this is by far the most significant mode of transmission. Stocking density is a determinant of the rate of spread of the disease, which may spread extremely rapidly in intensive farming areas because of high stocking density and the level of challenge from both infected animals and the environment. Conversely, disease spread in extensive grazing areas in hotter climates can be more insidious. Levels of protection (either from convalescence or vaccination) can dampen the movement of viruses in a herd or flock.

Congregation of animals, for example at common watering-points, at gatherings for vaccination, dipping, shearing, etc. or through transhumance or nomadism, favours spread of the disease to new herds and areas. The disease can also be disseminated very rapidly by movement of infected animals through livestock markets and shows. In this context, animals that are excreting virus but have not yet developed obvious lesions are particularly significant.

The role of persistently infected animals in the transmission of FMD has been uncertain. Transmission from carrier to susceptible cattle has not been demonstrated experimentally. However, there is evidence from Africa of transmission of the virus from carrier buffaloes and cattle under field conditions. This requires close contact and is probably a rare event.

- **Indirect transmission.** The FMD virus is easily spread mechanically by a variety of fomites including animal foodstuffs, bedding, equipment, livestock holding areas, vehicles (particularly the transport compartment of livestock vehicles), clothing, etc. that have been contaminated with infected secretions and excretions (saliva, milk, faeces and urine). Climatic and environmental factors will determine how long the virus will
Nature of the disease

Persist on fomites. Veterinarians and other workers who have close contact with livestock are at risk of carrying the virus from farm to farm.

- **Swill feeding of pigs.** Uncooked swill that contains virus-contaminated meat scraps or dairy products has a high potential for spreading infection. Swill originating from aircraft and ships has been incriminated as a major source of infection and has been responsible for a number of cases of international spread of the disease.

- **Windborne spread.** Infection by wind over considerable distances in temperate climates is believed to have occurred in several outbreaks in Europe. Although most windborne spread over land is confined to 10 km, a spread over water of 250 km may have occurred in the case of the Isle of Wight outbreak in 1981. The pattern of windborne spread has generally been from pigs at source to cattle downwind, and is likely to occur only when there are high concentrations of the appropriate livestock species at these locations. Additionally, the following climatic conditions are required: slow and steady wind speed and direction, high relative humidity (optimally above 60 percent), weak sunlight and absence of heavy rain. Long-distance windborne transmission has not been observed in Africa, the Middle East, Asia or Latin America.

- **Artificial breeding.** Transmission of the FMD virus can occur through artificial insemination using infected semen. However, embryo transplantation using properly collected and washed embryos with intact **zona pellucida** (using protocols described by the International Embryo Transfer Society [IETS]) does not constitute a risk.

**Disease patterns**

The introduction of the virus (or a new serotype) to previously free herds, areas or countries is likely to lead to a very rapidly spreading epidemic with high morbidity rates.

The epidemiological pattern of the disease tends to be different in temperate and tropical/semitropical parts of the world. In the former, the greater survival of the virus in the environment means that indirect transmission through fomites may be as important as direct contact between infected and susceptible animals. Windborne virus spread is possible under some environmental circumstances.

On the other hand, in hotter climates indirect means of transmission assume less relative importance than direct means of transmission. It is often the movement of potentially infected animals and
livestock trading patterns that provides the key to understanding the epidemiology of FMD in such areas.

**CLINICAL SIGNS**

The incubation period in naturally acquired disease is variable and depends mainly on the animal species, strain of virus, exposure dose and route of entry. It may be as short as two to three days, but can be as long as 10-14 days with very low doses of virus. The incubation period for index cases in an outbreak tends to be longer than for subsequent cases; it may be as short as 18-24 hours when the disease is experimentally produced.

**Cattle**

The first indication of the disease is a fever (to 42°C), which is accompanied by severe depression, inappetence and a sudden cessation of milk production. This is followed within a day or so by the development of vesicles, the predilection sites for which are the tongue, lips, gums, dental pad, nares, interdigital skin of the feet, coronary bands, bulbs of the heels and teats of milking animals. Occasionally vesicles appear inside the nostrils or on the muzzle, ocular canthae prepuce or vulva. The lesions begin as small hyperaemic foci at one or more of these sites. Lesions very quickly progress to vesicles initially 1-2 cm in diameter but that rapidly enlarge and often coalesce. They are filled with a clear straw-coloured fluid and their overlying epithelium is blanched. The vesicles rupture within 24 hours to leave raw, painful ulcers surrounded by ragged tags of necrotic epithelium.

In the mouth, vesicles are particularly prominent on the tongue, dental pad and gums. In severe cases, most of the mucosa of the dorsal surface of the tongue may slough. The painful stomatitis associated with unruptured and freshly ruptured vesicles causes excess salivation, lip smacking and cessation of eating. There is rapid loss of body condition. In uncomplicated cases, mouth lesions heal fairly rapidly over about a ten-day period and eating may resume within a few days of rupture of vesicles.

Acute lameness and reluctance to move accompany foot lesions, and secondary infections may lead to severe involvement of the deeper structures of the foot. The inability to move may lead to severe dehydration, loss of body weight, and debilitation as affected animals cannot cover distances to drink or eat. Teat lesions may also be complicated by secondary mastitis.

Although there is a very high morbidity rate, the mortality rate in adult animals is generally less than 5 percent. There is often a
prolonged convalescence with significant losses of meat and milk production, and of draught power. Pregnant animals may abort. Long-term sequelae may include foot deformities and permanent damage to the udder. Occasionally, endocrine gland damage leads to heat intolerance and a chronic “panting” syndrome characterized by dyspnoea and ill thrift.

Infection of very young calves may cause sudden death, without vesicular lesions, as a result of cardiac lesions. The mortality rate in such animals can be 50 percent or even higher, aggravated by the fact that milk production in affected dams is diminished or will not allow the offspring to nurse.

Highly productive animals tend to suffer more severely. The clinical signs of FMD in native breeds of cattle in endemic areas are usually milder than those described above.

**Pigs**

Early signs of FMD in pigs include fever, inappetence and reluctance to move. The most pronounced vesicles are on the feet. These vesicles cause acute lameness, pain and recumbency, particularly if the pigs are housed on a hard floor. Pigs may walk on their knees. However, the disease is sometimes difficult to detect when affected pigs are housed on soft bedding. Vesicles may occur on the coronets, interdigital skin, dew claws or bulbs of the heel. Lesions may also develop on the knees and hocks. Vesicles that encircle the coronet may lead to separation of the keratinized layers of the hoof from the corium. In severe cases there may be sloughing of the hoof. Otherwise, a line of separation between old and new horn moves steadily down the hoof at a rate of about 1 mm a week, starting a week after the rupture of coronary band vesicles. The age of FMD lesions in pigs can often be estimated in this way.

Vesicles often occur on the snout. Usually there is a single large vesicle on the dorsum of the snout behind the nasal rostrum. Vesicles on the tongue are relatively uncommon in pigs, and when they occur are small and heal rapidly.

Sows often develop vesicles on their teats. Pregnant sows may abort. There may be high mortality in suckling piglets, with sudden deaths from myocarditis, but no vesicular lesions. In some herds this is the first overt sign of the disease.

**Sheep and goats**

FMD is generally much milder in sheep and goats than in other species, and often escapes detection. Mouth lesions are not prominent.
Vesicles are most likely to occur on the dental pad and the posterior portion of the dorsal surface of the tongue. They tend to be small and heal rapidly.

Foot lesions are difficult to identify and most often occur along the coronary band and interdigital skin. It is often necessary to reflect the hair at the coronary band in order to visualize lesions. Lameness is often the only overt sign of FMD in a flock and must be distinguished from other causes of lameness. Foot lesions in sheep and goats are particularly prone to secondary bacterial infections, including foot rot.

As in other species, sudden deaths commonly occur in young lambs and kids as a result of cardiac lesions. The mortality rate may be as high as 90 percent, but is more usually about 50 percent.

**PATHOLOGY**

**Gross pathology**

Apart from the lesions that may be seen by external examination of the live animal, vesicular lesions may also be seen on the rumen pillars and possibly in other epithelial sites of the forestomachs of

**DETERMINING THE AGE OF FOOT-AND-MOUTH DISEASE LESIONS**

Being able to determine the age of lesions, especially when FMD is first recognized in a herd, is a useful aid to determining the approximate time of first infection, and thus in tracing back to the origin of infection. The table below gives some indicators as to the appearance of lesions at various phases of their development. It is of more value in cattle and pigs than in small ruminants, given the fact that clinical disease in sheep and goats is relatively mild.

<table>
<thead>
<tr>
<th>Approximate age of lesions</th>
<th>Appearance of lesions</th>
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<tr>
<td>1 day</td>
<td>Unruptured vesicles containing some fluid, early signs of necrosis in overlying epithelium</td>
</tr>
<tr>
<td>1-2 days</td>
<td>Unruptured, fluid-filled vesicles, overlying epithelium necrotic</td>
</tr>
<tr>
<td>1-3 days</td>
<td>Vesicles ruptured, erosions present and ragged pieces of epithelium adhering to the margins of the lesions. In the earlier phase, the exposed centre of the lesion is bright red; later the redness begins to change as fibrin deposition occurs</td>
</tr>
<tr>
<td>4 days-1 week</td>
<td>Erosions with little epithelium attached, margins of lesions becoming “smoother” (no longer ragged) because of early healing with regrowth of epithelium at the edge of the lesion</td>
</tr>
<tr>
<td>7-10 days</td>
<td>Healing advanced with fibrous tissue formation</td>
</tr>
</tbody>
</table>
ruminant animals. Myocardial lesions are common in young animals. Irregular grey necrotic foci may give rise to a striped appearance (the so-called “tiger heart”) of myocardium/epicardium of the heart.

**Histopathology**

The histological lesions of FMD are not highly specific but in early infection appear as multilocular fluid-filled vesicles in the *stratum spinosum* and cells that undergo acantholysis. Myocardial hyaline degeneration characterizes fatal cases of FMD. Confirmation of diagnosis should not be based on histopathology.

**Immunity**

Circulating neutralizing antibodies develop within four to ten days of infection. Convalescent animals usually have a very long immunity to reinfection (as long as at least five years) with closely related virus of the same serotype, but remain fully susceptible to other serotypes.

The degree of protection after vaccination is greatly influenced by the antigenic relationship between the vaccine strain and the challenge strain. Vaccines provide only partial immunity against antigenic variants of the same serotype. Potent vaccines confer immunity as early as four days after injection. However, vaccinal immunity is not long lasting and therefore revaccination at regular intervals (e.g. 6-12 months) is required. Manufacturers of commercial FMD vaccines normally recommend a primary immunization regime of an initial dose followed within three to four weeks by a second dose of vaccine. However, in endemic situations it is more usual to give two doses at six months apart and to revaccinate thereafter at yearly intervals. A proportion of vaccinated animals, although protected against the clinical disease, may become subclinically infected after natural challenge and excrete virus. It is important to note that animals incubating the disease when vaccinated may still develop the disease, sometimes in a milder form, and that vaccinated, exposed animals may still transmit infection for 7-14 days after vaccination and exposure.

**Field diagnosis**

Susceptible animals exhibiting excess salivation, lameness and other suggestive clinical signs should be examined carefully for vesicular lesions. If these are found, FMD should be strongly
suspected and appropriate action taken immediately to secure a definitive diagnosis and prevent any further spread of the disease while this is being done. This action includes collecting appropriate diagnostic specimens (or calling for a visit to be made by a specialist diagnostic team), notifying the provincial veterinary officer (PVO) and/or chief veterinary officer (CVO), and implementing or advising on immediate quarantine measures. Personal disinfection should be carried out after inspecting suspect animals and in no circumstances should another farm be visited on the same day.

**Differential diagnosis**

FMD can be clinically indistinguishable from other vesicular viral diseases of livestock, namely:

- swine vesicular disease (which occurs only in pigs)
- vesicular exanthema (which occurs only in pigs)
- vesicular stomatitis (which occurs in cattle, horses and pigs).

These vesicular diseases are fairly distinctive if animals are seen in the early acute clinical stage when there are unruptured or freshly ruptured vesicles. However, there have been incidents in several countries in which vesicular lesions have been observed on the snouts and/or feet of pigs, for which the aetiology could not be determined, despite thorough virological investigations.

A number of other viral diseases can be confused with the viral vesicular diseases, particularly during the later more advanced clinical stages. These include:

- rinderpest
- bovine papular stomatitis
- mucosal disease/bovine viral diarrhoea
- infectious bovine rhinotracheitis
- bluetongue
- peste des petits ruminants
- contagious echthyma.

Although mouth and muzzle lesions in these diseases are not vesicular, they could be confused with older lesions of FMD. Of the above diseases, foot lesions occur only in bluetongue and mucosal disease. Other diseases that may also be confused with the viral vesicular diseases are:

- *Dermatophilus* and other types of mycotic stomatitis
- phototoxic dermatitis with vesicle formation from contact with the leaves of plants of the family Umbelliferae (parsnips, parsley and celery)
- chemical irritants and scalding
• foot rot
• traumatic lesions of the mouth or feet

Foot lesions of FMD may be complicated by secondary bacterial infections that can mask the underlying cause. When herds or flocks are being investigated for vesicular diseases, it may be necessary to wash the feet of the animals carefully so they are free from mud and other debris before they are examined. Infected feet are often excessively warm. It is often necessary to reflect the hair at the coronary band to reveal small lesions in sheep.

The heart lesions of encephalomyocarditis (EMC) virus infection in pigs may also be confused with those of FMD in piglets.

If there are sudden deaths in young ruminant animals, Rift Valley fever, enterotoxaemia and bluetongue should be considered in the differential diagnosis.

Laboratory diagnosis

Laboratory confirmation of a presumptive diagnosis of FMD depends upon isolation of the virus, detection of viral antigen or detection of antibodies (as long as the antibodies can be demonstrated to result from infection rather than vaccination). Detailed instructions for laboratory diagnostic procedures for FMD are to be found in the Manual of standards for diagnostic tests and vaccines (OIE, 2000). The following is a summary, with emphasis on tests that are usually used.

Collection and transport of diagnostic specimens. The preferred sample for virus isolation/antigen detection is epithelium (at least 1-2 cm square) from unruptured or freshly ruptured vesicles. Vesicular fluid should be added if available. Samples should be collected into a transport medium consisting of equal amounts of phosphate buffer and glycerol at pH 7.2-7.6 (with added antibiotics). The special containers, and advice for dispatch should be sought first.

Laboratory diagnosis should only be attempted by trained personnel in well-equipped laboratories that have adequate biosecurity.

Virus isolation. The FMD virus is best isolated in primary cell cultures of bovine thyroid or pig, calf or lamb kidney. Established cell lines such as BHK-21 and IBRS-2 may also be used, but are less sensitive. The virus may also be isolated by inoculation of tissue suspension in unweaned mice.

Negative results can only be reported after two passages of the sample in tissue culture. This may take up to four days. It is
therefore extremely important to obtain the best possible quality of lesion material for dispatch to the laboratory.

**Antigen detection.** The two most commonly used tests are:

- the complement fixation test (CFT); and
- ELISA (an indirect sandwich test).

ELISA has largely replaced the CFT. The latter is sensitive and easier to apply but, as with all tests, needs to be properly standardized to optimize its sensitivity and specificity.

**Antibody detection.** Serological tests for FMD include:

- the virus neutralization test (VNT): this is a sensitive serotype-specific test, which requires three days to provide a result;
- the ELISA test (liquid or solid phase blocking): this is another sensitive serotype-specific test. It is now widely used because it provides fast results and does not require elaborate tissue-culture laboratory facilities as does the VNT. Positive results can be obtained within five hours of the laboratory receiving the sample;
- ELISA tests to detect antibodies against FMD non-structural proteins (NSP): the preparation of modern FMD vaccines results in the depletion of NSP. Sera from vaccinated animals contain antibodies against structural proteins, but not against NSP such as 3ABC or 2C. ELISA tests for NSP antibodies are major FMD diagnostic advances as they allow antibody titres that result from FMD infection to be discriminated from those resulting from vaccination.

Both the VNT and ELISA are OIE-prescribed tests for international trade.

**Detection of viral genetic material.** Reverse transcriptase (RT) polymerase chain reaction (PCR) tests are available for FMD. PCR is a highly sensitive and specific technique but, because of the possibility of cross-contamination, as well as expense, its use is practically confined to laboratories with a considerable degree of sophistication that have this capacity for other diseases.

**Tests under development.** Additional diagnostic tests are under development and validation. These include pen-side tests for the detection of the FMD virus and antibody and the application of automated, mobile equipment for the rapid application of the RT-PCR test.
Risk analysis is something that people do intuitively in their everyday lives and in their professional work. Only recently has it developed into a more formal discipline that is being used increasingly in many fields. In animal health it has perhaps been most widely applied in import control and quarantine. Quarantine risk analyses are used for helping to decide the most appropriate health conditions for imported animals and animal products and for strategies for quarantine operations.

Risk analysis is a tool that can also be used to very good advantage for animal disease emergency preparedness planning. In this context, it is most readily applied to preparedness planning for the occurrence of transboundary animal diseases (or exotic strains of endemic disease agents) and it will be described for this purpose here. However, there is no reason why risk analysis cannot be applied to other animal health emergency planning.

Risk analysis comprises four components: risk identification, risk assessment, risk mitigation or management and risk communication.

**Risk identification**

In this first component, the risks of untoward events or things that may happen in the future are first identified and then described. In the context of animal health emergencies, this would include identification of all high threat diseases (exotic or otherwise); the factors that may change the level of risk (e.g. new serotypes or biotypes, or changing epidemiological or livestock husbandry patterns); and factors that may impinge on the capacity of the national animal health services to respond effectively to the disease threats.

**Risk assessment**

The likelihood of these risks occurring is then estimated. The potential consequences of the risks if they occur are also evaluated.
and used to modify the assessment of the risk. For example, an exotic disease that had a high risk of entry to a country, but only a low risk of establishment or trivial potential socio-economic consequences for the country, would only get a low overall score in a risk assessment. Conversely, a disease assessed as having a low risk of introduction but significant consequences if introduced would be rated more highly.

Risks can be assessed in a quantified, semi-quantified or qualitative way. It is inherently very difficult to quantify (or actually ascribe probability percentages to) risks in many biological systems because of the lack of historical precedents and serious gaps in available biological data. Risks should be quantified as far as is practicable. If this cannot be done, qualitative risk assessments are recommended for exotic diseases. Risks can be described as extreme, high, medium and low, or preferably by a simple scoring system, for example, 1-5 for both the level of risk and for the degree of potential consequences. This will help to establish a priority ranking for identified risks, and provide a solid platform for contingency planning.

**Risk mitigation or management**
This is the process of identifying, documenting and implementing measures to reduce identified risks and their consequences. The risks posed by FMD can never be completely eliminated. The aim is to adopt procedures that will reduce the level of risk to what is deemed to be an acceptable level.

This manual could be regarded as providing the risk management framework for FMD contingency planning.

**Risk communication**
This is the process of exchange of information and opinions on risk between risk analysts and stakeholders. Stakeholders in this context include all those who could be affected by the consequences of the risks (i.e. everyone from farmers to politicians). It is important that risk assessment and risk management strategies be fully discussed with stakeholders so that they feel comfortable that no unnecessary risks are being taken and the risk management costs are a worthwhile “insurance policy”.

To ensure ownership of decisions, risk analysts and decision-makers should consult with stakeholders throughout the whole process of risk analysis so that the risk management strategies address stakeholder concerns, and decisions are well understood and broadly supported.
The risk assessment component is best carried out by the Epidemiological Unit in the National Veterinary Service as part of the national early warning system for transboundary animal diseases (TADs) and other emergency diseases. Risk management and risk communication are tasks for everyone, but should be coordinated by the chief veterinary officer (CVO).

It should be remembered that risks do not remain static. They will change with factors such as evolution and spread of epidemic livestock diseases internationally; emergence of new diseases; changing international trading patterns in the country; and new scientific knowledge and technology. Risk analysis should therefore not be regarded as a one-off activity but be repeated and updated regularly.

As described above, risk assessment consists of identifying the risks, assessing the likelihood of their occurrence and modifying/reducing them where possible by an evaluation of their potential consequences.

The international status and evolution of outbreaks of FMD (and other important TADs) as well as the latest scientific findings should be constantly monitored. This should be a routine function of the Epidemiological Unit of the National Veterinary Service. Apart from the scientific literature, the most valuable source of information is the International Office of Epizootics (OIE), for example through its weekly disease reports, the annual OIE World Animal Health and through the OIE Handistatus database. Disease intelligence is also available from FAO, particularly in the EMPRES Transboundary Animal Diseases Bulletin, which is published quarterly (and is also available on the Internet at www.fao.org/empres). The Program for Monitoring Emerging Diseases (ProMED), an Internet server and mailing service, currently provides a useful forum for rapid dissemination of official and unofficial information on animal, plant and human disease occurrences around the world. Information may also be obtained from designated OIE and FAO experts and reference laboratories and from regional groups established to coordinate FMD control such as the European Commission for the Control of Foot-and-Mouth Disease (EUFMD), the Pan American Foot-and-Mouth Disease Center (Panaftosa) and the Southeast Asian Foot-and-Mouth Disease Campaign (SEAFMD).

Having identified and listed the exotic disease threats, the next step is to assess the seriousness of the threat of entry of each
disease to the country\(^1\) and the routes and mechanisms by which the disease may enter. Relevant questions to be answered for FMD include the following:

- What is the current geographic distribution and incidence of FMD, including that of its serotypes, around the world?
- Is the distribution fairly static or has there been a recent history of spread to new countries, regions or continents (for example the international spread of the Pan-Asia strain of type O during the period 1990-2001)?
- Have any new antigenic subtypes emerged that may threaten even countries that routinely vaccinate against the disease?
- How close is the disease? What is the status of neighbouring countries, not only in respect to the known presence of FMD, but also the level of confidence in their veterinary services to be able to detect and control outbreaks of the disease?
- If FMD is present in neighbouring countries, where are the nearest outbreaks to shared borders?
- Are there any feral or wildlife animal populations in the country that are susceptible to FMD and that may introduce the disease (e.g. through natural migrations) and/or act as a reservoir for the disease?
- Is there a past history of introduction of FMD to the country? Is it possible that it is still present in undetected endemic pockets of infection in domestic, feral or wild ruminant animals and pigs?
- How is the disease likely to be spread in the country? What would be the relative roles of live animals and their movements; fomites; meat or other animal products; animal genetic material; windborne spread, etc. in transmitting the aetiological agent?
- Are there significant imports of potential risk animal species, meat products or other materials for FMD? Do they come from endemic regions? Do quarantine import protocols conform to OIE standards? How secure are import quarantine procedures?
- How secure are barrier and border import controls/quarantine procedures to prevent unlawful entry of risk materials for FMD?
- Is swill feeding of pigs a common practice in the country? Are there adequate safeguards to make this practice safe?

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\(^1\) Risk assessment can also be conducted with zones or regions of a country that have different animal health status. The principles are generally the same and require very fine knowledge of one’s animal health status, marketing infrastructure, transportation and regulatory capabilities.
• Are there smuggling, unofficial livestock movements, transhumance or nomadism practices that would constitute a risk for the entry of FMD? In particular, is there political instability/civil unrest in neighbouring countries that might result in major movements of people and movement or abandonment of livestock?

• Where are infected animals likely to cross the border and where are the main livestock trading routes from these areas?

The next step is to evaluate how serious the socio-economic consequences might be if the disease occurs. There are a number of questions to be answered:

• Is the disease likely to become established in the country? Are there susceptible livestock host populations?

• Is the disease likely to become established in feral animal or wildlife populations?

• Will it be difficult to recognize the disease quickly in different parts of the country?

• How big are the populations of cattle, pigs, sheep and goats in the country? What are the livestock management and trading systems? How important are those livestock industries to the national economy? What is their importance in satisfying nutritional (food security) and other community needs?

• How are these livestock industries structured within the country? Are there large commercial and/or intensive production industries or do they consist of smallholder/village production or extensive pastoral systems? Is production concentrated in just a few areas of the country?

• How serious will the production losses be from the disease? Will food security be threatened? What will be the socio-economic consequences?

• Is there an actual or potential export trade in livestock or livestock products? If so, how important is this export trade for the national economy? What would be the likely reaction of importing countries if FMD were found in the country? What would be the socio-economic consequences, both at a local and national level, of the loss of export trade for an extended period?

• What are the likely consequences on internal trade in livestock and livestock products?

• Are there populations of cattle, water buffaloes, pigs, sheep or goats that are poorly controlled and allowed to roam freely or are feral, and that may constitute reservoirs of FMD infection that are difficult to control?
• How difficult and costly will the disease be to control and eradicate? Can it be eradicated? All resources including both direct and indirect costs should be considered.

• Are there likely to be adequate trained human resources and physical and financial resources available to mount an effective response against an incursion of the disease?

By addressing these questions and issues it will be possible to build up a risk profile for FMD, uncover weaknesses and make judgements on the magnitude of the risk presented by the disease in qualitative, if not quantitative, terms. Most important, it will be possible to get an idea of how FMD ranks in relation to other high-priority risk diseases, and what resources need to be devoted to preparedness for FMD in comparison with other diseases. Possible pressure points for entry of the disease can be ascertained, showing where preventive and disease surveillance activities need to be strengthened. Finally, it should indicate whether the veterinary services and contingency planning need to be strengthened to cope with FMD.

It should be recognized that many risk factors will vary over time, which is one of the many critical reasons why this manual needs to be periodically reviewed.

The type of risk assessment described will help to:

• determine where FMD ranks in the priority list of serious disease threats for the country and what level of resources should be devoted to preparing for it in comparison with other diseases;

• determine how and where quarantine protocols and procedures need to be strengthened;

• determine how laboratory diagnostic capabilities need to be strengthened;

• plan training courses for veterinary staff and farmer awareness and publicity campaigns;

• determine how and where active disease surveillance needs to be strengthened;

• plan disease response strategies.
The old maxim that prevention is better than cure is very relevant when dealing with FMD and other transboundary animal diseases. Import control, including quarantine, is the first line of defence against these serious livestock diseases, and all countries should devote an appropriate level of resources to ensuring that they implement effective border and import quarantine policies and programmes to prevent introduction of these diseases. Because of the infectious nature of FMD and other TADs, often a country’s strategy is best served by working in and for a regional strategy or programme.

Risk analyses for FMD should provide an estimate of the degree of risk of introduction of the disease; the most likely mechanisms and portals of FMD entry; and the potential seriousness of the consequences if the disease enters the country. This should provide the basis for designing and implementing appropriately resourced preventive strategies for FMD.

The most important resource in the prevention of FMD (or any other livestock disease) is the informed animal owner or manager. Livestock owners at all levels of production, dealers and traders should be familiarized with the basic features of FMD, including recognizing the essential signs of the disease, the need for urgent action and how and where to seek help if they suspect the disease. This can only be achieved by intensive farmer training, using media that are easily understood, highly visual, and that serve as a constant reminder of the disease and its importance. Lines of communication must be established between livestock owners and the veterinary services, using local authorities and agricultural personnel as intermediaries when necessary, who should also be informed about FMD. It is after all the livestock farmers and/or herders who see their animals every day and, consequently, informed farmers and herders constitute the most important frontline surveillance resource for animal diseases.
The *OIE International Animal Health Code*, Chapter 2.1.1 on FMD, provides guidelines for the safe importation of live animals, meat and other animal products, germplasm and other risk materials from FMD-free and infected countries and zones.

Import quarantine conditions should be negotiated with exporting countries for the safe importation of the above based on the OIE Code. These may include pre-export testing and quarantine, animal health certification and any necessary post-arrival inspection, testing and quarantine.

Attention should be paid to the provision of adequate quarantine services to intercept foodstuffs and other risk materials containing meat or other animal products brought into the country at international airports and seaports and through border crossing-points. Any confiscated quarantine risk materials should be disposed of safely by deep burial or preferably incineration, as should all food waste from international aircraft and ships and long-distance lorries. The immediate adulteration of confiscated material (e.g. addition of spent motor oil and caustic soda) has been used to ensure that such products are not carried off by unauthorized personnel or disinterred by humans or scavengers.

The uncontrolled movement of animals across national borders presents a particular problem for many countries from an animal health perspective. This often occurs through trading when there is a price differential between countries for live animals or meat. It may also be a result of nomadism, transhumance, civil disruptions or inflow of refugees. The problem is compounded when borders are in difficult terrain or are relatively inaccessible. While efforts should be made to ensure that adequate quarantine provisions are applied for such animals, a degree of sensitivity is required. The application of quarantine restrictions that are too harsh may just encourage smuggling and be counterproductive.

In these circumstances it is recommended that close relations be developed between local animal health authorities, livestock traders and those who are likely to bring animals across borders. This should include an education campaign on the dangers of FMD and other serious transboundary animal diseases. Cooperation leading to simple, practical quarantine and disease surveillance procedures should be encouraged. At the same time a good working relationship should be developed with animal health authorities in neighbouring countries, both at the national and local levels for cooperation on
quarantine and exchange of early warning information on disease occurrences near mutual borders.

**SWILL FEEDING CONTROLS**

The swill feeding of food scraps (which may contain imported animal products) to pigs is a major way in which FMD and a number of other serious transboundary animal diseases such as African swine fever, classical swine fever and swine vesicular disease may be introduced into a country. Therefore consideration should be given to banning swill feeding or at least implementing practices that will make it safe, such as requiring the swill to be boiled for at least one hour.

Every effort should be made to prevent swill feeding of food waste from international aircraft or ships, as this constitutes a high risk of introduction of these transboundary diseases. Facilities should be made available for the incineration or safe burial of food scraps, unused food and animal products taken from incoming passengers by quarantine officials (see also the section on Barrier and border quarantine policy on p. 28).

Although bans on swill feeding are goals to be aimed at from the point of view of disease prevention, the impossibility of monitoring the situation at the household level renders this difficult to achieve in many countries. For many pig producers in rural, peri-urban and urban situations, economic circumstances dictate that any affordable available food source be used. This is likely, especially in the urban and peri-urban situation, where many poor people are highly dependent on their pigs for extra income, to emanate from a variety of sources, almost inevitably on a sufficiently informal basis to be beyond the reach of the law. Therefore, the only possible way to obviate the danger is for pig owners to understand the dangers and to opt voluntarily to boil the swill for an appropriate period before feeding it to their pigs. Where poverty prevails, the law is usually no deterrent and only comprehension of a risk and a practical means to overcome it will ensure compliance with regulatory measures. In countries with a developed pig industry, where pig farming is a business, it is possible that the law will guide farmers, and banning swill feeding might offer protection.

**CONTAINMENT OF LIVESTOCK**

The presence of large numbers of uncontrolled or poorly controlled pigs in an area or country constitutes a high risk for the entry and rapid spread of FMD and other serious diseases such as African or
classical swine fever. There may be significant delays in recognition of the disease and eradication will be much more difficult. Perhaps the greatest danger is that these pigs have access to the carcasses of pigs that die or are disposed of in the bush or on rubbish dumps, where they may be exposed to contaminated food scraps. Countries should take measures to encourage the development of properly constructed pig pens and farms and to reduce the numbers of scavenging pigs, particularly in areas that are considered to be at high risk of entry of FMD and other diseases. Groups that include pig farmers at all levels should speed up the process of commercialization, encouraging the establishment of pig farmers’ organizations. However, it must be accepted that the traditional ways of keeping pigs in many developing countries will not be changed overnight, and that permanent confinement of pigs imposes obligations to provide feed that owners may be unable to meet. The merit of pigs is their ability to convert low-grade feed, including human detritus, into high-quality protein, and until much more research has been done on alternative feeds for pigs, many producers will not find it worthwhile to confine their pigs. Additionally, in a number of countries sanitation is not readily available, and pigs provide a valuable cleansing service. The best that can be hoped for in the short term is that informed pig owners in villages will understand the dangers of disposing of the carcasses, offal and remnants of dead/slaughtered animals on rubbish dumping areas where pigs scavenge. A national policy for upgrading pig production that includes identifying sources of cheap feedstuffs should be put in place.

Countries that have endemic FMD in wildlife or feral animal populations need to consider what can be done to limit the possible close contact between potentially infected wild animals and susceptible livestock, and transfer of the disease to the latter. This may involve limiting livestock farming in some areas of the country, development of immune belts, or even the erection of physical barriers such as double fencing.
Prevention strategies for FMD

The old maxim that prevention is better than cure is very relevant when dealing with FMD and other transboundary animal diseases. Import control, including quarantine, is the first line of defence against these serious livestock diseases, and all countries should devote an appropriate level of resources to ensuring that they implement effective border and import quarantine policies and programmes to prevent introduction of these diseases. Because of the infectious nature of FMD and other TADs, often a country’s strategy is best served by working in and for a regional strategy or programme.

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Chapter 5

**Early warning contingency planning for FMD**

INTRODUCTION

Early warning mechanisms enable rapid detection of the introduction of or sudden increase in the incidence of a serious disease such as FMD before it develops to epidemic proportions and causes serious socio-economic consequences. The mechanisms embrace all initiatives, mainly based on disease surveillance, reporting and epidemiological analysis, that lead to improved awareness and knowledge of the distribution and behaviour of disease outbreaks (and of infection) and that allow forecasting of the source and evolution of disease outbreaks and monitoring of the effectiveness of disease control campaigns.

The success of a country’s capability for rapid detection of introduction or increased incidence of FMD depends on the following:

- good farmer and public awareness programmes for FMD and other high-threat epidemic livestock diseases, which involve improving the veterinary/farmer interface;
- training of field veterinary officers (FVOs), veterinary auxiliary staff, private veterinarians, agricultural extension officers, local authorities and livestock owners in the clinical and gross pathological recognition of FMD and other serious epidemic livestock diseases; collection and transportation of diagnostic specimens (in the case of veterinary staff); and the need for prompt action;
- sustained active disease surveillance, to supplement and improve passive monitoring based on close coordination among livestock owners, field and laboratory/epidemiology veterinary services, and the use of techniques such as participatory epidemiology techniques, serological surveys and abattoir monitoring to supplement field searching for clinical disease;
- dependable, rapid emergency disease reporting mechanisms to regional and/or national/federal veterinary headquarters;
- implementation of an emergency disease information system.
Early warning contingency planning for FMD

(such as the Transboundary Animal Diseases Information System [TADInfo]);

• enhancement of laboratory diagnostic capabilities, sample collection, and dispatch for FMD within provincial and national veterinary laboratories;
• development of strong linkages between national laboratories and regional and world reference laboratories;
• strengthening of national epidemiological capabilities to support emergency preparedness and disease management strategies;
• prompt and comprehensive international disease reporting to OIE by all countries and particularly to regional animal health organizations;
• close liaison with veterinary authorities in neighbouring countries both at a national level and at a local level near shared borders.

It is beyond the scope of this manual to discuss the above issues in any detail. For more information, reference should be made to the Manual on the preparation of national animal disease emergency preparedness plans (FAO Animal Health Manual No. 6) and the Manual on livestock disease surveillance and information systems (FAO Animal Health Manual No. 8). However, a few of the most important issues for FMD early warning preparedness will be described below.

In many countries it is likely that very few veterinarians or other animal health workers in either the public or private sector will have had any direct, first-hand experience with FMD or other transboundary animal diseases, as these diseases may never have occurred in the country or have been exotic for a considerable period. If FMD is rated as a high-threat disease, this deficiency needs to be rectified by a systematic training programme for all those people who, in their professional capacity, may possibly be the first to come into contact with an incursion or outbreak of the disease. Because a disease may strike in any part of the country and because of staff turnover, training programmes should be both comprehensive and regular. Training must extend to staff in the remotest parts of the country, as well as to selected officials (agricultural extension officers, local authorities) and livestock owners.

In other countries where FMD may be endemic, complacency as to the occurrence of the disease must be overcome if efforts are truly to control the disease progressively. It must be a desired
outcome by all parties: private and public. In training sessions, the shared benefit of FMD control must be underlined and the critical nature of the country’s investment for the public good understood.

Obviously, it will neither be practicable nor necessary to train personnel to a high level of expertise in these diseases. In most cases it is sufficient that trainees be at least familiarized with the basic clinical, pathological and epidemiological features of FMD and with what they need to do if they suspect one of these diseases. Perhaps the most important thing to inculcate in people is an attitude of mind – if they are confronted by an unusual disease outbreak involving foot-and-mouth lesions in ruminants or swine, they should include FMD in the range of their differential diagnostic possibilities and act accordingly and immediately. They should be trained in the steps that they need to take to secure a confirmatory diagnosis, including collection and transport of diagnostic specimens, and in the immediate disease control actions that need to be instituted at a disease outbreak site. More specialized training will be needed for those personnel who are nominated as members of specialist diagnostic teams (see section on the Specialist diagnostic team on p. 35).

A number of training possibilities may be selected, as appropriate. These include:

• Sending key field or laboratory staff to another country to gain first-hand experience when there is an FMD outbreak there, or making use of any other opportunities offered for field and laboratory staff to profit from the experience of countries in the process of controlling an outbreak (e.g. by attending workshops).

• Other international training opportunities that may occur from time to time. Several countries with access to microbiologically high-security laboratory and animal facilities run training courses in which exotic diseases can be demonstrated by experimental infection of susceptible livestock species. These courses are run in countries such as Australia, the United States, the United Kingdom and South Africa and there are opportunities for external students to attend. There is also the possibility for laboratory staff to be trained at world or regional reference laboratories; training programmes may also be arranged occasionally by other international organizations. During project (assistance) proposals, participation in these courses should be budgeted.

• National emergency disease training workshops, which should
be organized as the mainstay of training and be targeted at
government field and laboratory veterinary officers, public
health and quarantine veterinarians (including those stationed
at abattoirs, markets, border posts, airports and seaports),
vetinary practitioners, and industry veterinarians. Ideally,
these workshops should include representatives from neighbouring
countries, and should filter down, by means of workshops
organized by those who have been trained, to farmer level.

- Field diagnostic manuals, which are most useful if they are
  prepared in a simple, practical and graphic format whereby
  they can always be carried in a vehicle and be available for
  quick reference at the site of a disease outbreak.

These programmes form part of the most critical, but sometimes
neglected, aspects of preparedness planning for emergency diseases,
and for fostering “ownership” of and support for emergency
disease control/eradication campaigns by livestock farmers, community
leaders, and other key stakeholders. They also engender a bottom-
up approach to planning and implementation of disease control
programmes, to complement the more traditional top-down approach
adopted by governments.

Communication strategies should aim to make stakeholders
aware of the nature and potential consequences of FMD and other
important livestock diseases and of the benefits to be derived from
their prevention and eradication. Furthermore these strategies
should always have an element of rallying the community to the
common cause of preventing and fighting a disease epidemic, ideally
resulting in farmer sanitary defence groups and farmer organizations.

One of the important messages to get across is that it is essential
to notify and seek help from the nearest government animal health
official as soon as an unusual disease outbreak is seen in ruminant
animals and pigs. Publicity campaigns should not only be directed
towards farmers but also towards local authorities and livestock
traders.

One of the more delicate aspects of notification of a suspect case
of FMD or other highly infectious disease in an animal population
is the perceived repercussions this may have on the individual
reporting the case. Confidentiality must be preserved if the report
is exposing someone else’s livestock, and appreciation and gratefulness
exemplarily shown if people report disease occurrence in their
own animals.
Livestock traders, dealers and marketers are essential target groups for public awareness campaigns and are often overlooked. The movement of animals through livestock traders is often the key epidemiological factor in the spread of FMD and other epidemic livestock diseases. The need to build up a climate of trust and confidence between animal health officials and livestock traders is as important as that discussed for farmers. The general themes for emergency disease awareness should also be similar although emphasis should be placed on the importance of doing the “right thing” about sourcing animals from disease-free areas where possible; not buying any sick stock; following rules about quarantine, vaccination, testing or identification of animals; and keeping records. The potential consequences of the occurrence of a disease on internal and international trade should be emphasized.

It is recommended that a specialist FMD diagnostic team (or teams) be nominated within a country so that the team can be immediately mobilized when there is a report of a suspect outbreak of vesicular disease from the field. These arrangements should be made well in advance of any emergency. Members should be available, prepared and equipped to travel to a disease outbreak site at short notice. The site should have all the equipment needed for the preliminary investigation of a disease, for collection and transport of diagnostic specimens, and for rapid and immediate communications.

The composition of the diagnostic team will vary according to circumstances, but could include:

• a veterinary pathologist from the central or regional veterinary diagnostic laboratory;
• a specialist epidemiologist, preferably with first-hand experience or training in FMD;
• a veterinarian with extensive experience of endemic diseases in susceptible livestock species;
• any specialist required for specific examinations.

If there are people with expertise in more than one of the above areas, the size of the diagnostic team can be reduced accordingly.

The team would travel to a disease outbreak site with local veterinary staff if so directed by the chief veterinary officer (and would be provided with the transport to do so). The specialist diagnostic team should seek local authority assistance (e.g. community elders, agricultural representatives and local leaders) to facilitate subsequent actions.
The specialist diagnostic team would be expected to:
• make clinical examinations;
• collect histories;
• make preliminary epidemiological investigations, particularly with regard to tracebacks (have any new animals joined the infected herds in the last four weeks and where did they come from?) and traceforwards (have any animals left the infected herds in recent weeks and where did they go?);
• collect a range of diagnostic specimens both specifically for FMD and for any endemic or exotic diseases that might be included in the differential diagnosis and transport these back to the laboratory.

The team should also have the authority to take immediate disease control actions that are necessary at the outbreak site. They should be empowered to provide any immediate instructions to local animal health officials.

The team must report back immediately to the state/provincial/ regional veterinary officer and the CVO on their assessment of the situation, including steps taken to secure a confirmatory diagnosis. They should also advise on further disease control strategies, including declaration of infected and surveillance zones, any necessary measures to improve disease reporting from the outbreak area and the desirability of setting up a local disease control centre.

The rapid and certain diagnosis of diseases can only be assured in fully equipped laboratories with a range of standardized diagnostic reagents, experienced staff and a sufficient throughput of diagnostic specimens to maintain expertise. Additionally, the development of diagnostic expertise for exotic diseases for tests that require handling the live agent should only be attempted in microbiologically high-security laboratories.

It would therefore be impractical and excessively costly for most countries to maintain a national veterinary diagnostic laboratory with full capabilities for confirmatory diagnosis of all transboundary and other emergency diseases, many of which will be exotic. However, it is to be expected that at least those countries with significant livestock populations will have a veterinary diagnostic laboratory that is equipped and competent to undertake a broad range of standard techniques in pathology, virology, bacteriology and serology to the level where preliminary identification of aetiological agents for most, if not all, emergency livestock diseases
can be attempted. If FMD is deemed to be a very high-threat disease, consideration should be given to developing capabilities for some primary key diagnostic tests, e.g. ELISA tests for both antigen and antibody detection.

Specimen transport containers with transport media should be kept at both central and state or provincial veterinary laboratories and should be made readily available for FVOs and specialist diagnostic teams. These containers should ideally be leakproof primary containers such as glass or plastic universal bottles with a screw top and rubber washer, or good-quality plastic screw-top jars. These are then packed into a leakproof secondary container with absorbent material and an ice pack to keep specimens fresh. This is finally placed into a robust cool box or other container with good labels. Specimen advice notes should also be provided (see Chapter 2, Diagnosis on p. 16). Copies of all details dispatched should be documented.

A network of FAO and OIE Reference Laboratories and Collaborating Centres exists for FMD around the world and is available for providing advice and assistance to countries. Names, full contact details, subjects and geographic areas of responsibility are given in the Appendix.

As part of their FMD contingency planning, countries should establish contact and a dialogue with the appropriate reference laboratories and collaborating centres. Countries should determine the nature and range of diagnostic specimens or isolated agents to be sent for confirmatory diagnosis or further characterization; any transport media to be added; method of packaging and refrigeration; labelling of package, including correct address; and any necessary customs or International Air Transport Association (IATA) declarations. This information should be documented in the emergency preparedness plans.

It is very important that potential or confirmed aetiological agents from emergency disease outbreaks be sent to the appropriate international reference laboratory for further characterization. It is recommended that several isolates from different geographic locations and at different phases of the outbreak be forwarded. Submission of samples to any laboratory outside the country of origin should always be subject to prior agreement with the recipient and be transported in containers meeting IATA regulation standards.
Full use of reference laboratories and collaborating centres should also be made for the help that they can provide in training opportunities, provision of specialized advice and standardized diagnostic reagents.

It is particularly important for countries that are employing FMD vaccination programmes to engage as a matter of routine in disease surveillance activities that will provide early warning of any changes in the FMD serotypes or subtypes circulating within the country. Indicators of this might be a sudden upsurge in the incidence of the disease or the occurrence of vaccination breakdowns. Such occurrences should be immediately investigated and diagnostic samples collected for virus characterization.

Vaccinating countries should also routinely collect representative field samples of FMD virus strains from all outbreaks and representative areas in the country at least once or twice a year and send them to an international reference laboratory for strain characterization. This will ensure that the most appropriate vaccine strains can be selected for use in the country and the epidemiological evolution of the disease can be tracked.
Chapter 6

Early reaction contingency planning for a FMD emergency

This manual mainly addresses the situation where FMD invades a country, or a zone within a country, which was formerly considered free from FMD. Should such an emergency occur, all initiatives would be directed at rapid containment of the disease to the primary focus or zone of infection, and eradication within the shortest possible time to avoid spread and possible progression to an endemic status.

However, the strategies enunciated may also be used by FMD endemic countries to help them plan better control programmes and progressively to eradicate the disease.

Countries should aim towards a goal of verifiable eradication, which will enable a documented case to be presented for international (OIE) recognition of national or zonal freedom (with or without vaccination).

There are a number of epidemiological and other factors that influence the control and eradication strategies selected for FMD. These include the following.

- There is no cross-immunity among the seven serotypes of the FMD virus. Within the serotypes, there is a spectrum of antigenic variation that may lead to reduced immunity.
- FMD is one of the most contagious of epidemic livestock diseases and can spread very rapidly. Early warning is therefore essential to detect an incursion while it is still localized. Early and decisive reaction is required if the disease is to be contained and eventually eliminated without serious socio-economic consequences. To be effective, the control measures must be applied in the shortest possible time, since action within hours, never mind days, is crucial to success.
- Pigs are important amplifying hosts for the disease, cattle are regarded as good indicator hosts, whereas sheep tend to show...
few clinical signs and are often considered maintenance hosts for a relatively short period where movement and transport can be responsible for virus spread.

- Humans are not susceptible to FMD infection, but often transmit the virus mechanically.
- Infected animals may excrete the virus for up to a few days before exhibiting clinical signs.
- A proportion of recovered cattle, African buffaloes and sheep remain virus carriers for variable periods.
- Wild or feral ruminant or porcine animal populations may act as reservoirs for infection.
- Direct contact between animals is the most significant method of transmission, but the virus may persist for considerable periods in the environment (particularly in temperate climates) and mechanical transmission by fomites is also considerable.
- The FMD virus may persist for long periods in certain meat and dairy products, and swill feeding of these to pigs is another significant method of transmission, especially in the international and intercontinental spread of the disease.
- Windborne spread over considerable distances is possible in temperate climates. Local airborne spread may also occur in many environments. Computer modelling can to some extent predict this spread, which may be useful for zoning and surveillance purposes.
- In hotter climates, direct contact is by far the most significant method of transmission and an understanding of livestock movement and trading patterns is vital for the framing of FMD control and eradication strategies.
- Inactivated vaccines are widely used for FMD, but vaccine strains must be carefully matched to prevailing field virus strains if a satisfactory level of protection is to be attained; vaccination cover must attain a level of at least 80 percent for effectiveness; and good census information is essential to verify true coverage percentages.
- Some virus strains have a higher predilection for one or another livestock species (e.g. pigs or cattle), which has significant implications for the planning of vaccination campaigns.
- The immunity afforded by vaccines does not last long. Vaccination and revaccination campaigns need to be carefully targeted, comprehensive and consistently applied.
- A proportion of vaccinated animals can become subclinically infected if they are subsequently exposed to the homologous
virus and may be able to transmit infection for up to 14 days after vaccination, even when they become immune to the development of clinical disease.

• Serological tests that allow discrimination between antibodies resulting from infection and vaccination (NSP ELISA tests) are now becoming available and should permit more accurate monitoring of control and eradication programmes based on mass vaccination.

• Stamping out usually leads to more rapid eradication of FMD than vaccination but in the short term is very expensive and resource intensive. Apart from strictly veterinary considerations, public perceptions and environmental concerns must be taken into account. Combined strategies are very useful in many circumstances.

The basic principles that can be applied to the control and eradication of FMD are:

• **Denial of access of the virus to susceptible host animals**
  - through import controls and quarantine, including control of animals in transit;
  - through good hygiene and sanitary practices; removing potentially contaminated materials from the environment by cleaning, disinfection and/or safe destruction; and preventing the feeding of contaminated materials to livestock.

• **Avoiding contact between infected and susceptible animals**
  - through zoning, quarantine of infected or potentially infected farms or areas, livestock movement controls and perhaps the erection of fencing or other physical barriers.

• **Reducing the number of infected or potentially infected animals in livestock populations**
  - through slaughter of infected or potentially infected animals and safe disposal of their carcasses by deep burial or burning or (preferably) rendering.

• **Reducing the number of susceptible animals**
  - through destocking and/or comprehensive vaccination programmes.

The strategy chosen is likely to be a combination of some or all of these approaches. There is no single FMD eradication strategy that is perfect or even appropriate for all circumstances. The emphasis given to the various methods in devising FMD control and eradication strategies will depend on epidemiological factors,
livestock husbandry systems, community acceptance and likely cost.

A stamping-out policy will probably be most appropriate for countries with highly developed livestock industries, particularly for those with a substantial actual or potential export trade in livestock and livestock products to protect. In the latter context the downtime from loss of national FMD-free status and inability to export, is likely to be less, not only because eradication may be achieved more quickly by stamping out, but also because there is a subsequently shorter period before an international declaration of FMD freedom can be made and accepted. While large-scale stamping-out campaigns are extremely expensive and resource intensive in the short term, they may be outweighed by overall lower production and trade losses.

Stamping out is a viable proposition if an outbreak can be detected early while still reasonably localized and contained by quarantine and livestock movement controls. An essential prerequisite is that good epidemiological capabilities exist, which allow the locations and extent of the infected areas to be rapidly and accurately determined. This involves not only good disease surveillance, but also livestock identification systems that facilitate traceback and traceforward of possibly infected animals.

Countries that plan a stamping-out policy should also have a fall-back position. They should have a vaccination plan, which can be applied if the rate of FMD spread gets out of hand and outstrips the resources for stamping out. Ring vaccination, targeted blanket vaccination or suppressive (dampening-down) vaccination in selected areas can be applied to decrease the rate of spread of virus infection. Vaccination can also be used for intractable foci of infection. A decision can be made later as to whether it is desirable to slaughter vaccinated animals to get a declaration of FMD freedom for trade purposes more quickly.

For most countries, large-scale stamping out is not a viable option. In these cases emphasis must be given to targeted vaccination campaigns, supported where possible by livestock movement controls and judicious stamping out. Eradication can be achieved in this way if done systematically.

Zoning is the proclamation of geographic areas in which specific disease control actions are to be carried out. These areas are usually in the form of concentric “circles” around known or
suspected foci of infection, with the most intensive disease control activities in the inner zones. Zoning is one of the early actions to be taken when there is an incursion of FMD in a country. The actual size and shape of the zones may be determined by administrative boundaries or geographic barriers, or be driven by epidemiological or resource imperatives. However, because the spread of FMD is mainly by means of movement of infected animals, animal products or contaminated materials, it is very important not to lose sight of the fact that transmission can occur over hundreds or thousands of kilometres by road or air overnight. It would therefore be short-sighted during an epizootic to depend upon the declaration of infected zones to contain the disease, unless there is a high level of confidence that the movement of livestock or other dangerous materials, such as meat, from infected to free zones can be prevented by geographic barriers or instituted control measures. Experience has shown that the establishment of an effective cordon sanitaire in many countries is far from simple and that such measures are easily evaded. It is certain that poorly organized farms distant from the zone of infection may be at greater risk than well-managed commercial farms within the infected zone.

**Infected zone(s)**

The infected zone encompasses the area immediately surrounding one or more infected farms, premises or villages. While its size and shape are influenced by topographical features, physical barriers, administrative borders, epidemiological considerations (including the likelihood and possible direction of windborne spread), this zone is generally recommended to be at least a 10-km radius around disease foci in areas with intense livestock raising and 50 km in areas where extensive livestock raising is practised.

The size and shape of the infected zone(s) are also influenced by the type of disease control activities to be carried out. If intensive stamping out is planned it could be desirable for the size of the infected zone to be at the minimal end of the spectrum. If, on the other hand, zoning is to be used as the basis for planning vaccination campaigns, the infected zone(s) may be larger.

In the initial stages of an outbreak, when the extent of the infected zone is not well known, it would be prudent to declare larger infected zones (and even an all-inclusive national zone), impose movement restrictions accordingly, and then progressively reduce them when active disease surveillance reveals the true
extent of the outbreak.

**Surveillance zone(s)**

The surveillance zone is larger than the infected zone it surrounds and can also include more than one infected zone. It acts as a buffer zone between infected and FMD-free zones. Known livestock movement patterns should be taken into account when defining surveillance zones, which may cover a whole province or administrative region and, in some cases, the whole country.

**FMD-free zone(s)**

These zones encompass the rest of the country. However, because of the potential of FMD for wide dissemination, it would be unwise to regard any part of a country in the throes of a new outbreak as not requiring a high level of surveillance. The emphasis in free zones should be on strict quarantine measures to prevent entry of the disease from infected zones and continuing surveillance to provide confidence of continuing freedom. These zones should be subjected to the same degree of information dissemination as the zones in which the outbreak occurs. This information should be extended, through good and rapid communication, to neighbouring countries.

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**Stampingout**

**Introduction**

Eradication of FMD by stamping out is only likely to be successful if a number of prerequisites are in place, which will require careful

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<th>ESSENTIAL PREREQUISITES FOR AN FMD STAMPING-OUT CAMPAIGN</th>
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<tr>
<td>• Political and community support</td>
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<td>• Well-defined infected area(s) based on comprehensive disease surveillance programmes</td>
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<td>• Capabilities to seal off infected areas through quarantine and livestock movement controls</td>
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<td>• Well-trained personnel and access to necessary financial and other resources (equipment, materials, etc.)</td>
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<td>• Appropriate legal powers</td>
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<td>• Capabilities to slaughter infected animals and safely dispose of their carcasses rapidly, and for cleaning and disinfection</td>
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<td>• Assistance available from agencies such as customs, police, public works department and defence forces</td>
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<td>• Provision of fair and timely compensation to farmers for slaughtered livestock and other property destroyed</td>
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COMPENSATION

It is essential that farmers and other people who have had their livestock slaughtered or property seized should be fairly compensated at current market value. This compensation should be paid without delay. Valuation for compensation purposes should be undertaken by experienced, independent valuers. Alternatively, generic valuation figures could be agreed upon for specific categories of livestock. At least the market value of the animals should be paid. Under some circumstances, replacement of stock may be offered in lieu of monetary compensation. If replacement of stock after a suitable period is considered to be a better alternative than cash compensation, this should be confirmed in consultation with livestock owners.

Failure to pay adequate and timely compensation will seriously compromise FMD eradication campaigns by causing resentment in communities and a lack of cooperation and will act as a spur for the illegal smuggling and clandestine sale of animals from infected areas to avoid losses.

Actions to be taken in infected zones

The overall aims in the infected zone are twofold, to:

• prevent the further spread of infection through quarantine and livestock movement controls; and
• remove the sources of infection rapidly, through slaughter of potentially infected animals, safe disposal of carcasses and decontamination procedures.

Disease surveillance and other epidemiological investigations.

Trained veterinary officers or inspection teams undertake intensive active surveillance for FMD, with frequent clinical examination of herds and flocks. These officers or teams should wear protective clothing and practise good personal decontamination procedures.
to prevent taking infection to the next farm they inspect.

At the same time, traceback and traceforward investigations are carried out whenever an infected herd is found. Tracing back determines the origin of any new cattle, pigs, sheep or goats that had been brought on to the infected premises in the three weeks before the first clinical FMD cases (and which may have been the source of infection) and then the farms in question are inspected. Tracing forward determines the destination of animals that have left the infected premises prior to or after the first clinical cases. All farms that may have become infected by these animals are then inspected. However, traceback and traceforward investigations quickly become complicated if animals have transited through livestock markets.

Tracing should include all animal movements as well as the movement of vehicles and personnel concerned with feed lorries, milk tankers, animal dealers, and so on.

Farms that are impeccably managed (accredited) within the infected zone can be treated as if they were a small island of a surveillance zone (see section below). Caution must be exercised in determining this status as expensive or attractive structures, facilities or animals are sometimes misinterpreted as good management.

**Quarantine of infected and dangerous contact premises.** These premises are epidemiological entities where animals have become infected – whether a single farm or household or an entire village or settlement, or even a livestock market or abattoir. Dangerous contact premises are those for which there are reasonable epidemiological grounds to suspect that they have become infected, even though the disease is not yet clinically apparent. The infection may be caused by close proximity with infected farms; mingling of animals; movement of people, vehicles, equipment, materials, etc.

All infected and dangerous contact premises should be immediately quarantined with a ban on the exit of live animals, meat and dairy products and other potentially contaminated materials, pending further disease control action (see section below). Vehicles and other equipment should be disinfected before leaving the premises, paying particular attention to the interior transport compartment of vehicles used for the transport of live animals.

**Movement controls.** It is essential to impose a complete ban on the movement of live susceptible animal species and animal products within and out of the infected zone. Great care is required to ensure that neither animals nor animal products are smuggled out of the
zone. Because of the high risk that they constitute for spread of infection, livestock markets and abattoirs should be closed.

It may be necessary to set up control points or roadblocks at exit points from the infected area(s) to prevent unauthorized movements.

**Slaughter of infected and potentially infected livestock.** All susceptible livestock species in infected and dangerous contact premises, or in a larger area if this is deemed necessary, are immediately slaughtered, whether they are obviously diseased or not. Owners should be asked to collect and confine their animals the day before the slaughter team arrives. The animals should be slaughtered by methods that take account of animal welfare concerns and the safety of operatives. Means of animal restraint (crushes, sedative drugs and means for their application, etc. may be required). Rifles or captive bolt guns are most commonly used for the culling of livestock. Captive bolt pistols should be used in confined areas where there is danger of ricochets. Use of a captive bolt should take into account the fact that the animal may be stunned and not necessarily killed, and appropriate measures taken to ensure that the animal is dead before burial or burning. Rifles should be used only by competent and experienced marksmen to avoid threatening the safety of people and non-target animals. Lethal injections (e.g. barbiturates) may also be used if practical.

In cases where animals are poorly confined or are allowed to scavenge in the surrounding countryside, it may be necessary to send out special teams to locate and shoot animals, using trained marksmen.

Reference should be made to the *Manual on procedures for disease eradication by stamping out*, FAO Animal Health Manual No. 12 (FAO, 2001) for more information on slaughter procedures.

**Safe disposal of carcasses.** This is the disposal of carcasses of all animals that have either been slaughtered or have died naturally of FMD, where the carcasses no longer constitute a risk of further spread of the pathogen to other susceptible animals either by direct or indirect means, e.g. by carrion eaters or scavengers or by contamination of food or water. *Carcasses should be disposed of as quickly as possible (preferably within 24 hours).* This is most usually done by deep burial covered by quicklime (depending on factors such as the nature of the terrain, closeness of water tables to the surface, and availability of earth-moving equipment) or by burning (depending on the availability of suitable fuels and the danger of starting grass or bush fires) or by rendering. Where
rendering is used, the live animals and/or carcasses should be transported in leakproof vehicles. If in situ disposal is not practical it may be possible to transport carcasses to a common disposal point in these sealed vehicles. This should be done within the infected zone wherever possible.

Reference should be made to the Manual on procedures for disease eradication by stamping out, cited in the section above, for more information on disposal procedures.

**Decontamination.** This involves the thorough cleaning and disinfection of the environs of infected premises, with particular attention to where animals have congregated, including animal houses, sheds, pens, yards, water troughs, and so on. Potentially contaminated materials such as manure, bedding, straw and feedstuffs should be removed and disposed of in the same way as for carcasses. It may also be simpler to burn very poorly constructed pens, for example.

Preliminary thorough cleaning should be undertaken with copious water to which soaps and detergents may be added. Appropriate disinfectants for FMD include sodium hydroxide (2 percent w/v in water), sodium carbonate (4 percent w/v in water) and citric acid (0.2 percent w/v). Sodium carbonate is preferred to sodium hydroxide as it is less corrosive. New commercial disinfectants have recently become available that are less corrosive or less environmentally harmful (contact EMPRES for further details).

Reference should be made to the FAO Manual on procedures for disease eradication by stamping out, cited above, for more information on decontamination procedures.

**Destocking period.** After slaughter, disposal and decontamination procedures have been completed, the premises are left destocked for a period, determined by the estimated survival time of the pathogen in the particular environment. As a general rule, this time is shorter in hot climates than in cold or temperate climates. However, a minimum of 30 days is recommended.

**Actions to be taken in surveillance zones**
The following disease control actions should be undertaken in surveillance zones.

- Active disease surveillance for FMD should be enhanced. Susceptible species livestock in the zones should be inspected at about weekly intervals and their owners questioned about disease occurrences and livestock movements, etc. Any sick animals should be thoroughly investigated, including dispatch
Preparation of foot-and-mouth disease contingency plans

...of diagnostic samples to the laboratory. The burden of this surveillance could be alleviated if it were practicable for some of the work to be delegated to the informed and trained farmers themselves.

- Movements of susceptible animal species and products from infected zones should be banned. Movement from surveillance to free zones may be allowed but only after health inspection and the issue of an official permit.
- Abattoirs, dairy factories and other risk enterprises could be allowed to operate but only when subjected to strictly enforced zoosanitary codes of practice.
- Sales of live animals, meat and dairy products can continue unless it is considered that they constitute a threat for the further spread of the disease. Sales should be subjected to record-keeping, surveillance and rigidly enforced codes of practice, including the official issue of movement permits.
- Pen-side tests that determine the state of infection could be applied in movements.

**Actions to be taken in disease-free zones**

The emphasis in FMD-free zones is on preventing entry of the disease and accumulating internationally acceptable evidence that the zones are indeed FMD free (see section on International collaboration on p. 57).

The entry of pigs or pig products from infected zones should be banned and only allowed subject to official permits from surveillance zones. Well-managed (accredited) farms within infected zones could be treated as if they were surveillance zones.

**Repopulation**

At the completion of the agreed destocking period, livestock may be reintroduced to previously infected farms or villages. Livestock used for repopulation *must* come from known FMD-free zones or countries and should preferably be certified infection free by means of not only clinical inspection but also serological testing. However, this should only be done if there is reasonable certainty that these farms/villages will not be reinfected from external or internal sources. Restocking at full capacity should only take place after sentinel animals have been introduced on each previously infected farm and observed closely for three to four weeks. The animals should be tested serologically with samples taken at the beginning (day 0) and at day 21 or day 28, to ensure they stay free...
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of FMD before full repopulation. Intermittent sampling may also be performed. After repopulation, intense active surveillance for the disease should be maintained in the area at least until international declarations of freedom can be made.

Introduction

FMD vaccination is, unfortunately, still carried out in a haphazard manner in many countries, resulting in the disease remaining endemic for long periods. It is far preferable for vaccination programmes to be carefully planned and then systematically implemented to achieve specific goals.

In cases where FMD has been introduced into a previously free country or region, an emergency vaccination campaign supplemented by other disease control methods may be used with the goal of eradication within a reasonably short time frame. Alternatively, in an endemic country, vaccination programmes may be planned to develop FMD-free zones progressively and eventually achieve national freedom.

Vaccination basics

Selection and supply of vaccines. Safe and potent inactivated vaccines, prepared using primary inactivating agents such as binary ethyleneimine, should be used. They should contain at least 3 PD 50 (protective dose for 50 percent of animals) and have a rated storage life of at least 12 months when stored at the correct

ESSENTIAL PREREQUISITES FOR FMD VACCINATION PROGRAMMES

- Political and community support
- Commitment by all stakeholders to a comprehensive vaccination programme applied consistently for a sufficient period of time
- Planning based on sound epidemiological evidence
- Availability of safe and potent vaccines
- Knowledge of circulating FMD serotypes and strains throughout the course of the vaccination programme
- Availability of adequate “cold chains”
- Accessibility of target livestock populations to vaccination
- Well-trained vaccination teams
- Disease surveillance systems to monitor effectiveness of vaccination and detect remaining pockets of infection
temperature. The vaccine may be multivalent but should contain only the required serotypes and strains for the country. For emergency vaccination in the face of an epidemic, vaccine should be at least double the normal minimum potency (i.e. at least 6 PD 50).

Pigs require FMD oily adjuvant vaccines, since they do not respond immunologically to the aqueous FMD (aluminium hydroxide-saponin) vaccines that are used for ruminants. Oil vaccines generate longer protection but are more expensive than aqueous ones, especially if a double-oil emulsion (water/oil/water) is used.

FMD vaccines should only be sourced from reliable manufacturers that conform to the OIE Manual of standards for diagnostic tests and vaccines (OIE, 2000). Supply of adequate quantities of FMD vaccine in an emergency may present a problem; countries therefore may consider it desirable either to join an international vaccine bank or make advance contractual arrangements with a reliable vaccine manufacturer.

Vaccination should follow the manufacturer’s instructions.

**Vaccination procedures.** The target livestock species for vaccination are generally cattle, water buffaloes, sheep, goats and pigs. One or other of these species should only be excluded from vaccination programmes if there is strong epidemiological evidence that they have little involvement in the outbreak(s). Other species (e.g. camelids) are seldom included in vaccination programmes.

During visits by vaccination teams to livestock farming communities it may be desirable to combine FMD vaccination with other vaccination, such as for haemorrhagic septicaemia, contagious bovine pleuropneumonia, sheep and goat pox. This will conserve resources and may also help to achieve a higher level of farmer cooperation in the FMD programme.

Vaccination teams should be well trained and adequately equipped with transport, injecting equipment (and the means for sterilizing it), cold-chain transportation, animal restraining equipment, recording forms, protective clothing and disinfectant.

Sites should be selected that will allow animals to be properly restrained so that vaccine can be carefully injected subcutaneously or intramuscularly, according to the manufacturer’s instructions.

**Animal identification.** Ideally, there should be a compulsory registration system for livestock and their vaccination. Failing this, they should be identified by ear tagging, ear notching or other
means that will confirm that they have been vaccinated and when.

**Emergency FMD vaccination campaigns**

These cover situations where FMD has been introduced into a previously free country or area in a country and where stamping out alone is not considered to be a viable option.

*Comprehensive emergency vaccination programmes supported by other disease control measures.* Zones are defined and proclaimed as recommended in the section on Zoning on p. 42. The infected zone(s) become the target area for an intensive vaccination campaign, encompassing not only the known infected farms/livestock farming communities but also those areas thought to be at high risk of infection. Known livestock movement and trading routes along which the disease may spread should be taken into account, as well as the natural geographic barriers and administrative areas of zone boundaries, together with epidemiological factors. Movement of susceptible species livestock and their products out of the infected zone should be banned. Unvaccinated animals should not be brought into the zone. Movement of animals within the zone may be allowed, although it is highly desirable that known infected farms be quarantined.

Comprehensive (or “blanket”) vaccination is carried out as quickly as possible within the target area. All susceptible livestock within the population should be vaccinated. FMD vaccination is safe for pregnant animals.

*Practical experience in a number of countries has demonstrated that the spread of FMD can be very quickly halted by an emergency vaccination campaign using a single round of vaccination, providing that a potent vaccine (6 PD 50 or higher) is used, and all or nearly all susceptible animals are immunized.*

In order to reduce the possibility of accidental spread of the disease:

- different vaccination teams should deal with herds suspected or known to be infected with FMD and other herds to be vaccinated in the area;
- operatives should be aware of the clinical signs of FMD and the immediate measures to be taken if the disease is encountered during vaccination;
- vaccination teams should disinfect between locations;
- equipment should be frequently sterilized and always sterilized between farms;
- partly used vaccine containers should be discarded between
farms and the amount discarded recorded;
• different herds should not be congregated or mixed for vaccination;
• in communities where many families own few animals, it is better to visit each family farm individually rather than congregate all the animals of a village.

A high level of disease surveillance activity should be maintained within the infected (vaccination) zone to detect any viral activity. Clinical surveillance may be supplemented by serological surveys to monitor the immune level in the population. The results of such surveys will become easier to interpret when tests that are able to discriminate between antibodies resulting from natural infection and vaccination become widely used.

Vaccination and, if so decided, the slaughter of infected and contact animals should be continued until either the clinical disease disappears from the target area or drops to such a low level that it can be tackled by other methods (e.g. stamping out). This may require two or more vaccination cycles, ensuring that excellent vaccine coverage is accomplished each time.

A surveillance zone should be maintained around the infected (vaccination) zone (see section on Zoning on p. 42).

**Emergency ring (or buffer) vaccination.** This involves the rapid creation of an immune belt around an infected zone. It may be done to contain a very rapidly spreading disease outbreak or in situations where the effectiveness of other methods to prevent the spread of the disease in and around infected zones, e.g. quarantine and livestock movement controls, cannot be guaranteed, or where these areas may be relatively inaccessible. A decision to implement ring vaccination needs to be made quickly or else the size and number of infected areas may make it impractical. The width of the immune belt should be determined by epidemiological factors and resource availability considerations but, as a general guide, should be of the order of 20-50 km. Speed is of the essence and vaccination in the target ring should ideally be completed in the shortest time.
possible (i.e. seven days). It is far preferable to select a narrower ring for which human resources, vaccines and other resources are available for comprehensive vaccination within this time frame rather than select a larger ring where gaps may be left in the immune belt for longer periods. The vaccination ring can be extended later when vaccination brigades have gained experience and become more efficient after the first phase. Having selected the target area for the ring, vaccination should commence at the outer circumference and move centripetally towards the infected herds or flocks. Separate vaccination teams should be used for herds/flocks in which infection is highly suspected. Ring vaccination will only prevent spread of infection if strict movement control is maintained from the infected area.

An immune belt can also be created, for example, along a border when there is an extremely high threat of entry of FMD and little else can be done to prevent it. In this case, depending on geographic and epidemiological considerations, an immune vaccinated belt of the order of about 50 km is reasonable. Every effort should be made to prevent animals moving through the immune belt. Immune belts should not be maintained over long periods when the threat has reverted to a low level.

This situation greatly complicates responses to FMD outbreaks. The potential or actual role of wild or feral animals as reservoir or maintenance hosts for FMD needs to be assessed epidemiologically in partnership with wildlife authorities.

Reduction programmes for susceptible wild or feral animals may be possible in infected areas. However, in the case of wildlife, it is very probable that these will be precluded on ecological or environmental grounds. If attempted, care must be taken to ensure that such programmes do not simply act to disperse potentially infected animals to new areas. In any event, attempts to control or reduce wild animal populations are only justified if there is good evidence that they are involved in the transmission of infection to wild animals – a relatively uncommon situation.

It may be possible to limit contact between susceptible wild and domestic animals and thereby reduce the chances of transfer of infection from one to the other. This could be done by double fencing, livestock-free buffer zones or removing livestock from epidemiologically important wildlife.

If none of these measures is likely to be practicable and/or
successful, it will probably be necessary to mount ring or blanket vaccination programmes for livestock in those areas where infection in wildlife constitutes a continuing threat for disease in livestock.

Surveillance activities should be extended to wild and feral animal populations, in collaboration with wildlife authorities.

Public awareness and education campaigns should be seen as integral and important elements of disease eradication campaigns and crucial for their success. These campaigns should be mainly (although not exclusively) targeted at rural and peri-urban communities that will be affected by the disease and FMD control actions. The most appropriate means of getting the message across to specific communities should be used, such as radio broadcasts and village meetings. The latter are particularly suitable since they give people the opportunity to ask questions and material (such as pamphlets and posters) can be disseminated that will reinforce the information given.

Campaigns should inform people of the nature of the disease and what to do if they see suspect cases; what they can and cannot do during the eradication campaign and why; and the benefits of getting rid of FMD. Campaigns should emphasize that FMD control primarily benefits livestock producers and not the government.

Public awareness material that is targeted specifically at all stakeholders should be prepared. As well as the above groups, material should be prepared for politicians, senior bureaucrats and the press. There may also need to be a publicity campaign directed at consumers to reduce unnecessary buyer resistance to animal products, based on perceived public health risks.

OIE specifies requirements for recognition of national FMD freedom with and without vaccination, together with zonal freedom with and without vaccination. The following is extracted from the OIE International animal health code: mammals, birds and bees (10th edition, 2001). It should be noted that, since these OIE requirements are subject to periodic changes, it is very important to consult the latest version.

**National freedom**

*FMD-free country where vaccination is not practised.* To be listed in FMD-free countries where vaccination is not practised, a
Early reaction contingency planning for an FMD emergency

A country should:
• have a record of regular and prompt animal disease reporting;
• send a declaration to OIE that there has been no outbreak of FMD and no vaccination carried out for at least 12 months, with documented evidence that an effective system of surveillance is in operation and that all regulatory measures for the prevention and control of FMD have been implemented;
• not have imported animals vaccinated against FMD since the cessation of vaccination.

The name of the country will be included in the list only after acceptance of evidence submitted by OIE.

FMD-free country where vaccination is practised. To be listed in FMD-free countries where vaccination is practised, a country should:
• have a record of regular and prompt animal disease reporting;
• send a declaration to OIE that there has been no outbreak of FMD for the past two years, with documented evidence that:
  - an effective system of disease surveillance is in operation and that all regulatory measures for the prevention and control of FMD have been implemented; and
  - routine vaccination is carried out for the purpose of the prevention of FMD; the vaccine used complies with the standards described in the Code; and there is a system of intensive and frequent surveillance for detection of any viral activity.

If an FMD-free country where vaccination is practised wishes to change its status to an FMD-free country where vaccination is not practised, a waiting period of 12 months after vaccination has ceased is required.

Zonal freedom
FMD-free zone where vaccination is not practised. An FMD-free zone where vaccination is not practised can be established in an FMD-free country where vaccination is practised or in a country where parts are still infected; and in countries with a surveillance zone, or physical or geographic barriers and animal health measures that effectively prevent the entry of the virus. A country in which an FMD-free zone where vaccination is not practised is to be established should:
• have a record of regular and prompt animal disease reporting;
• send a declaration to OIE that it wishes to establish an FMD-
free zone where vaccination is not practised, where there has been no outbreak of FMD for the past two years, where no vaccination has been carried out for the past 12 months, and where no vaccinated animal has been introduced into the zone since the cessation of vaccination;
• supply documented evidence that an effective system of surveillance is in operation in the FMD-free zone where vaccination is not practised as well as the surveillance zone, if applicable;
• describe in detail:
  - the boundaries of the FMD-free zone, and the surveillance zone, where vaccination is not practised;
  - the system for preventing the entry of the virus into the FMD-free zone, and supply evidence that this is properly supervised and that all regulatory measures for the prevention and control of FMD have been implemented;
• have a system of intensive and frequent surveillance for detection of any viral activity in the FMD-free zone where vaccination is practised.

The name of the free zone will be included in the list of FMD-free zones where vaccination is not practised only after acceptance of submitted evidence by OIE.

The name of the free zone will be included in the list of FMD-free zones where vaccination is practised only after acceptance of submitted evidence by OIE.

If a country that has an FMD-free zone where vaccination is practised wishes to change the status of the zone to an FMD-free zone where vaccination is not practised, a waiting period of 12 months after vaccination has ceased is required.

Very considerable mutual benefits can be derived through countries cooperating in their emergency animal disease preparedness planning. This applies particularly to neighbouring countries or countries within the same geographic region. Since such countries often have similar socio-economic, environmental, epidemiological and agricultural production profiles, they are also likely to have similar livestock disease risks and needs for and approaches to preparedness planning.

Countries in this situation may well consider pooling resources in their emergency animal disease preparedness planning. This may be done through informal networking or, more formally, through existing regional organizations such as Panaftosa in Latin America; the African Union/Interafrican Bureau for Animal Resources
Early reaction contingency planning for an FMD emergency (AU/IBAR) in Africa; OIE, the Animal Production and Health Commission for Asia and the Pacific (APHCA) and the Association of Southeast Asian Nations (ASEAN) in Asia; and the Veterinary Committee of the European Union (EU) and EUFMD in Europe. Not only will this ease the burden for all, but it will also, perhaps more important, result in harmonized plans and strategies for preventing and responding to emergency animal diseases within a region. This is particularly important in the case of transboundary animal diseases that, by definition, are prone to spread rapidly across national borders.

Potential avenues for collaboration include:
- joint risk assessments leading to harmonization of import quarantine policies and other disease prevention strategies in a region;
- joint development by countries that share common land borders of strategies and programmes to lessen the risk of FMD and other epidemic diseases being spread by the movement of potentially infected animals across the borders – through coordination of disease surveillance, quarantine, vaccination and other methods;
- coordinated animal health programmes for shared ethnic groups who practise nomadism and transhumance across borders;
- development of compatible disease reporting and information systems;
- information exchange on disease occurrences, etc. at a national level, and at a local level near shared borders;
- dividing responsibilities and possibly resources for preparing contingency plans for FMD and other shared high-threat diseases or at least exchanging ideas and draft plans;
- reciprocal arrangements for development of laboratory diagnostic capabilities;
- establishment of international vaccine banks;
- joint training field exercises, workshops and other training programmes.

There are also compelling reasons why countries should cooperate in their control and eradication campaigns for shared epidemic livestock diseases. A regional approach with well-coordinated campaigns in all countries is far more likely to succeed and will reduce the subsequent risk for all countries to a greater extent than if countries proceed alone. The future export opportunities of the countries will also be enhanced if diseases are eradicated on a regional basis.
Chapter 7

FMD control and eradication campaigns in an endemic situation

The strategies discussed in Chapter 6 were based on the premise that an emergency disease outbreak has been detected relatively early and is still only present in one or a few discrete areas. Countries that are not in this fortunate position and contend with endemic FMD should strategically consider whether a national disease eradication campaign is practical. The spreading of resources too thinly over too large an area may result in setbacks and frustrations all round.

It may well be more effective to tackle control and eventual eradication by vaccination in a step-by-step progression, moving from one region to the next. In this case, regions should be defined and selected on the basis that once eradication has been achieved in a region, and the campaign moves on to the next, there can be confidence that the first region is “secured” and that the disease will not re-enter. Geographic barriers should be utilized wherever possible. In this respect, archipelago countries are fortunate in that eradication can be done as an “island hopping” campaign. Otherwise use should be made of any epidemiological or livestock production and marketing patterns that tend to make an area a discrete unit in terms of disease spread.

Next is the question of prioritization for each region. There is merit in selecting the major livestock breeding areas in the country first, since these have the most to lose and, if infected, pose the greatest risk of further spread. Because of the number of animals involved, these areas may be important sources for the virus to appear in other parts of the country. Another advantage of tackling these areas first is that, when FMD-free, they will act as a valuable source of disease-free animals for restocking other areas.
Further prioritization should also be based on an understanding of epidemiological factors and livestock production and marketing systems, which influence how and where the disease spreads. Where FMD strikes is a reflection of how unprotected animals have encountered the virus from other animals or the environment, but the location may not be the origin of the virus. Often it may be more efficient to vaccinate animals “upstream” where the virus is present in its ecological niche, rather than wait for the virus to enter a large susceptible population “downstream”. Livestock movements and direct contact between animals are often overwhelmingly the most significant transmission of FMD. Therefore, a thorough understanding of livestock movement patterns and routes is often vital for effective prioritization within FMD eradication campaigns.

Vaccination should also be timed appropriately, taking into consideration seasonal animal husbandry and livestock movement patterns. Animals should be vaccinated at times of the year before movements are likely to occur, e.g. before dispersal of young stock and movement of animals to fresh pastures.

These incremental programmes for the progressive development of FMD-free zones by vaccination should be supported by strong disease surveillance programmes that monitor the effectiveness of the campaign, and also by livestock movement controls that will prevent the reinfection of areas freed of the disease.

Where eradication is the goal, vaccination should not be allowed to become just a routine activity that is maintained almost indefinitely because of fear of political consequences if it ceases and another outbreak subsequently occurs. When the clinical disease appears to have disappeared from either a region of a country or the whole country it is time to take stock of the situation and carry out a thorough epidemiological and economic assessment of future options.

It may well prove desirable to maintain strategic vaccination if there is still a very high risk of a new incursion of the disease from a neighbouring country. On the other hand, in many cases it is advantageous to change the course of action completely by stopping vaccination programmes altogether and moving to a disease “search and destroy” policy. This does not necessarily mean that fewer resources will be devoted to eradicating the disease in the short term. Rather they will be directed away from routine vaccination to increased early warning and early response activities. There
must be willingness to enhance active disease surveillance activities and maintain preparedness against the disease at a high level. In this way, any disease breakdowns can be detected and eliminated quickly by either a short, sharp, targeted vaccination campaign or by limited stamping out.
The country CVO (or equivalent, such as the Director of Veterinary Services [DVS]) should have overall technical responsibility for preparedness for and management of FMD emergencies. The appropriate government minister would of course be ultimately responsible.

In recent years the national veterinary services of many countries have been restructured and reduced. This has included, *inter alia*, regionalization and devolution of veterinary services; privatization of veterinary services and/or downgrading of government services; separation of policy functions from operational functions; and separation of administrative responsibilities of veterinary laboratories and veterinary field services.

These new structures have evolved to meet the demands of delivering routine animal health services better. However, they are often not well suited to managing a major animal health emergency such as an FMD eradication campaign. In an emergency there is a need to make decisions rapidly, based on analysis of the best information available from all sources. It is also essential that there is the capacity to convert those decisions into clear orders so that when they are conveyed down the chain, there is confidence and accountability that they have been carried out. Therefore, there must be efficient mechanisms in place for transmission of information and instructions from the national veterinary services headquarters right down to the frontline of the disease eradication campaign in the field and laboratory; and for feedback of information to headquarters.

It is clear that for these things to happen quickly and efficiently in an emergency, the national veterinary services must be placed in a *command structure* or *line management* system at least for the duration of the emergency response to an FMD outbreak.
There should be forward planning so that the most appropriate structures and lines of responsibilities can be rapidly and seamlessly put in place when an FMD emergency arises. Planning may include organizing one or more of the following well in advance of any emergency:

- An agreement that animal health emergencies will be handled at the national level and that the CVO will assume overall responsibility for responding to the emergency, and will be directly answerable to the appropriate government minister.
- A mechanism for cooperation among different ministries if necessary to control the disease (e.g. police, army, customs, wildlife, fire service, education, media and health). This cooperation usually necessitates the establishment of an interministerial committee. In view of the bureaucracy that may attend the constitution of such a committee in an emergency, it is advisable for the committee to exist on a permanent basis.
- An agreement with regional or provincial authorities that their veterinary staff will come under the line management of the national CVO for an animal health emergency response programme. Arrangements also need to be put in place to ensure that regional field and laboratory veterinary services are fully involved in emergency preparedness planning and training activities, and are in collaboration with national veterinary headquarters in providing early warning of emergencies (including emergency disease reporting to national headquarters).
- Similar arrangements for all essential government veterinary services, including the central veterinary laboratory, to come within the command structure of the CVO (if this is not already the case) for the purposes of the emergency response.
- Pre-existing contractual agreements for private sector veterinary organizations, universities, other academic institutions and research institutes to provide essential services during an animal health emergency.
- Negotiation with the national veterinary association over terms and conditions for hiring practitioners and other private sector veterinarians as temporary government veterinary officers if needed.
- Plans for the employment of retired veterinarians and ancillary staff.

In many countries the private sector is extremely small, or non-existent, and it may be necessary to rely upon non-veterinary assistance for disease control. There should therefore be a mechanism
to mobilize resources available in other related sectors, e.g. agricultural extension, with appropriate training. It is vital to identify all the potential role-players in control of animal diseases and ensure that they are prepared to act immediately in the event of an epizootic.

Countries may find it very useful to establish a CCEAD, which can be convened as soon as there is an FMD emergency, and can meet regularly during the course of the emergency response. This would be principally a technical committee whose role would be to review epidemiological and other disease control information; recommend the activation of agreed contingency plans; maintain oversight of the campaign; and advise the CVO and the appropriate minister on the future planning of the campaign and on implementation of the plans.

A suggested composition of the CCEAD might be:
- CVO (Chairperson)
- Director of Field Veterinary Services/Director of Disease Control
- Head of the Epidemiological Unit
- Directors of State, Provincial or Regional Veterinary Services
- Director of the National Veterinary Laboratory
- Director of any regional veterinary laboratories covering the outbreak areas
- Senior representatives of farmer groups or organizations
- Representatives of other key groups, e.g. the National Veterinary Service, universities and military liaison
- Other technical experts, as required (with observer status).

The chairperson should seek input from members of the CCEAD in the spirit of a “consensus approach” to the emergency, but exhaustive deliberations should not be allowed and the CVO must select from the options presented.

Countries should establish a permanent National Animal Disease Control Centre. In the event of an outbreak of FMD or another emergency animal disease, the centre would be responsible to the CVO for coordinating all emergency disease control measures in the country. The centre should preferably be situated within the National Veterinary Service headquarters and the National Epidemiology Unit should be either attached to the centre or work
in close collaboration with it. The CVO may delegate day to day responsibilities for implementing agreed policy to the head of the centre, who would normally be a senior government veterinarian. The responsibilities of the centre in the emergency response would include:

- implementing the disease control policies decided by the CVO and the CCEAD;
- directing and monitoring the operations of Local Animal Disease Control Centres (see below);
- maintaining up-to-date lists of available personnel and other resources, and details of where further resources may be obtained;
- deploying staff and other resources to the local centres;
- ordering and dispersing essential supplies, including vaccines if they are to be used;
- monitoring the progress of the campaign and providing technical advice to the CVO;
- advising the CVO on the definition and proclamation of the various disease control zones;
- maintaining up-to-date lists and contact details of risk enterprises, etc.;
- liaising with other groups involved in the emergency response, including those that may be activated as part of the National Disaster Plan;
- preparing international disease reports and, at the appropriate times, cases for recognition of zonal or national freedom from the disease;
- managing farmer awareness and general publicity programmes, including press releases, and creating a public relations centre to liaise with the media;
- general and financial administration, including record-keeping.

The National Animal Disease Control Centre should be fully equipped with a range of maps covering all parts of the country (preferably at 1:50 000), and with suitable communication equipment for liaison with regional veterinary services or specially designated Local Animal Disease Control Centres, veterinary laboratories, etc. by telephone, radio, e-mail and fax as appropriate. The centre should also be linked with the Emergency Disease Information System.

During the FMD emergency, the district offices of the veterinary services closest to the infected foci or, where there are none, the
district offices of the agricultural extension services, should act as Local Animal Disease Control Centres. Ideally teams should be able to travel to and from any site necessary for surveillance or any other disease control activities in one day. Otherwise, possible locations for temporary local disease control centres (e.g. local government offices) should be identified and negotiated for in advance.

The regional and district veterinary officers should be in charge of disease control operations in their area, and have the right to enter farms, collect samples and take any measures deemed necessary to prevent the movement of livestock, livestock products and any other potentially contaminated materials within and outside the areas under their control. They should be provided with the necessary materials for collection, storage over short periods (a refrigerator) and transmission of samples; protective clothing; stores of disinfectant; a vehicle and fuel; and the means to contact the CVO as required. Provided the necessary political structures exist, officers should be able to enlist the cooperation of other services, e.g. the police, agricultural extension officers and the media, to prevent dissemination of disease. They should be provided with the materials needed to carry out a public information campaign and more intensive farmer training and information. Most important, they should at all times be in possession of accurate information relating to the status of the disease in the country and to slaughter and compensation levels.
Support plans provide the vital backing that will make the implementation of the FMD or other emergency disease contingency action plans possible.

Experience has shown that delay in obtaining finances is one of the major constraints to rapid response to emergency disease outbreaks. The immediate application of even modest funds will more than likely save major expenditure later. Forward financial planning is therefore an essential component of preparedness.

Financial plans need to be developed that provide for the immediate provision of contingency funds to respond to disease emergencies. These funds are required over and above normal operating costs for government veterinary services. The plans should be approved by all interested government parties, including economic planning authorities and the Department of Finance and must provide for the payment of compensation, overtime, employment of temporary staff, hire or purchase of equipment and materials, transport, fuel and miscellaneous expenditure.

Funds may cover the cost of the whole eradication campaign. More often, however, they will cover the initial phases of the campaign, pending a review of the outbreak, the control programme and the funds required to finalize eradication.

The conditions under which funds may be released should be specified in advance. Normally they would be provided to the CVO when he or she advises that:

• FMD or another emergency disease has been diagnosed or there are reasonable grounds to suspect that the disease is present;
• the outbreak is capable of effective control and/or eradication;
• there are approved plans in place to apply these measures.

The funds may be held as special funds, which are sequestered for the purpose, or there may be drawing rights provided up to a predetermined realistic amount against a specific government account.
In some countries it may be desirable for funds to be provided from both the government and private sector for emergency programmes against FMD and other agreed diseases. This funding would be agreed upon after a review of the nature and proportion of public and private good benefits to be derived from the elimination of the disease. If appropriate, a funding formula may be agreed upon that covers payment of a fixed percentage of the cost of the total campaign by each sector, or whereby each sector pays for specific components in the campaign. If the private sector is to contribute, it should be determined who stands to benefit in the sector (and therefore should share the cost). This may include processing industries and traders as well as farmer organizations. It also needs to be predetermined how the private sector funds will be raised, for example, by livestock industry levies (e.g. on livestock transactions or slaughtering) that are held in quarantined funds or by industry-wide insurance. Voluntary individual insurance policies are satisfactory for insuring against consequential losses from a disease or disease control actions but are unsatisfactory for raising funds for the campaign itself.

In many cases the funding of the whole emergency disease eradication campaign may be beyond the resources of the country. If this is the case, forward planning should be carried out to identify potential international donor sources for the campaign. This could include emergency support from FAO or appropriate international agencies. Procedures for applying for funding and requirements for preparing and submitting an application should be predetermined.

The first step in preparing a resource plan is to make a resource inventory. This is a listing of all the resources needed to respond to a moderate-sized FMD outbreak or other high-priority emergency disease. The plan includes personnel, equipment and other physical resources. The following resource list for different operations should be regarded as indicative rather than exhaustive.

**National Animal Disease Control Centre**

Senior disease control veterinarians and epidemiologists, financial and administrative officers and extra staff for recording and processing epidemiological and other information; national and regional maps (1:50 000 and 1:10 000); computers and software for animal health information systems, financial accounting, etc; and equipment
for communicating with local headquarters (e.g. telephone, fax and e-mail, if available).

**Local Animal Disease Control Centres**
Senior disease control veterinarians and epidemiologists, technical support and administrative officers; suitable offices and office equipment; maps; a telephone and fax, where possible; pro formas for various disease control operations (in some circumstances, more sophisticated equipment such as computers with the concomitant advantage of e-mail may be present and functional); cold storage for vaccines and diagnostic samples; and simple laboratory facilities for processing diagnostic samples.

**Diagnostic laboratories**
A biosecure laboratory or laboratories, preferably accredited, with trained laboratory staff; standard laboratory equipment plus any specialized equipment for key emergency diseases; diagnostic reagents for antigen and antibody detection; and provision for the receipt, labelling and secure storage of samples, from both diagnostic and serological surveillance activities.

**Diagnosis/surveillance**
Veterinarians and support veterinary auxiliary staff; transport; maps; communication equipment; leaflets or posters on the disease(s); equipment for collecting and transporting diagnostic samples, including blood; and animal restraint equipment.

**Slaughter, burial and disinfection**
Supervising veterinarian and personnel; transport; humane killers, ammunition and other approved means of killing animals; protective clothing; animal restraint equipment; front-end loaders and earth-moving equipment (depending upon local availability); approved disinfectants, soaps and detergents; shovels and scrapers; and high-pressure spraying equipment. If carcasses are to be incinerated, sufficient fuel (generally diesel mixed with a small amount of petrol), and old motor tyres to expedite the process by encouraging air circulation and maintaining enough heat.

**Vaccination**
Supervising veterinarian and personnel; vaccines; transport; cold storage during transport; syringes and needles; animal restraint equipment; eartagging equipment or other means of identifying
vaccinated animals; protective clothing; disinfectants and disinfection equipment.

**Quarantine and livestock movement controls**

Enforcement teams; transport; roadblocks (if necessary); and signs and posters.

The next step is to prepare a list of existing resources and their specifications, quantities and locations. A register should be maintained of specialist staff together with their qualifications, expertise/experience with FMD and contact details. These resource lists and staff registers should be maintained at the National Animal Disease Control Centre and, where appropriate, at Regional Offices.

Comparison of the inventory lists of needed and available resources will inevitably highlight many deficiencies. The resource plan should identify how these deficiencies will be rectified in an emergency.

There are several options for accessing the necessary extra resources:

- a list of where essential equipment and stores may be purchased, hired or borrowed;
- where items are hard to obtain or take time to prepare (e.g. pro formas) it may be desirable to maintain a central store (e.g. for disinfectants);
- arrangements for the supply of personnel and equipment from other government agencies, e.g. earth-moving equipment from the Department of Works, and transport and communication equipment from the armed forces;
- arrangements through veterinary associations for the temporary employment or secondment of veterinary practitioners, retired veterinarians and ancillary field and laboratory staff in an emergency.

Supply of diagnostic reagents presents special problems as international sources of these are limited. An international reference laboratory for FMD should be consulted about sources of reliable diagnostic agents.

It should be noted that to maintain adequate diagnostic capacity, laboratories should routinely perform basic tests on specimens of known and unknown status to ensure diagnostic proficiency and competence, and should send test samples to reference laboratories from time to time to cross-check results even when they are negative.
The resource plan and associated inventory lists need to be regularly updated.

**LEGISLATION**

Acts of parliament or government regulations that provide the legislative framework and power to carry out all necessary disease control actions need to be put in place as part of preparedness planning. These regulations may include legislation to:

- make FMD and other proclaimed animal diseases compulsorily notifiable;
- allow the entry of officials (or other designated persons) on to a farm or other livestock enterprise for disease surveillance purposes (including the collection of diagnostic specimens) and to carry out any other approved disease control actions;
- authorize the proclamation of infected and disease control zones;
- authorize the quarantining of farms or other livestock enterprises;
- authorize any bans on the movement of livestock, livestock products or other potentially contaminated materials, or the issue of permits to move these only under specified animal health conditions;
- authorize the compulsory destruction and safe disposal of infected or potentially infected animals and contaminated or potentially contaminated products and materials, subject to fair compensation and cleaning and disinfection of properties;
- authorize the destruction of feral animals and uncontrolled/poorly controlled livestock;
- provide for compensation to be paid to owners of livestock and property destroyed as part of disease control programmes and define standards for such compensation;
- allow zoosanitary codes of practice to be mandated for risk enterprises and activities (e.g. livestock markets, abattoirs and dairy factories) and authorize any necessary disease control actions;
- authorize the compulsory vaccination of animals;
- authorize the compulsory identification of animals, where appropriate;
- authorize other justifiable and necessary disease control actions.

For countries that operate under a federal system of government, there should be harmonization and consistency of legislation for animal disease emergencies throughout the country. The same should apply between countries within regions for which there is
unrestricted exchange of livestock and animal products under free trade pacts, e.g. the EU, the Mercosur countries in South America, and the Economic Community of West African States (ECOWAS) and the Southern African Development Community (SADC) in West and southern Africa respectively.

It is also critical to ensure that existing legal powers are properly enforced, possibly with the assistance of the police and the armed forces.
Chapter 10

Action plan

The action plan is a set of instructions covering most aspects of the controls to be implemented and actions to be taken during an FMD emergency, from when the disease is first suspected up to its final eradication.

Since veterinary structures differ from country to country, this chapter provides only a guideline of the actions to be carried out during each phase of an FMD outbreak. Every country should develop its own action plan in which the person or persons responsible for each action are clearly identified. Lines of communication between livestock owners and field and national veterinary services must be identified and made known to all parties. These communication lines underpin the command chain to be activated in the event of suspected FMD. The success of implementation of the action plan depends on each link in the command chain functioning as specified in the plan.

In addition, it is expected that countries will prepare detailed operating procedures, which are generic and apply to FMD as well as to other epidemic diseases. Additional manuals may be required to cover the zoosanitary code of practice in high-risk enterprises such as meat processing plants and livestock markets.  

The investigation phase commences once a report suspecting FMD has been received by the veterinary services. It should be a well-understood legal obligation of any citizen who suspects the

2 Countries may wish to consult the AUSVETPLAN manuals on control centre management, decontamination, destruction of animals, disposal procedures, public relations, valuation and compensation, laboratory preparedness, artificial insemination centres, dairy processing, meat processing, feedlots, saleyards and transport. However, the standards attained will vary from country to country and it is advisable for countries or regions to develop their own enterprise manuals based on local conditions, unless considerable similarity exists between their situation and that of Australia, which is an island with a highly developed economy, a highly developed commercial agricultural sector, a well-equipped and trained state veterinary service and a relatively sparse and sophisticated human population.
presence of FMD (or any other serious animal disease) to report to a member of the veterinary or animal health services, either directly or via any links in the previously identified chain of communication, e.g. the village assembly person, agricultural extension officer, or district or subprefectural authority. In essence, a suspicious index case or animals with suspect vesicular lesions are most likely to be reported to the local veterinary authorities by an animal health or agricultural extension officer, an abattoir or meat hygiene officer, farmers and livestock owners, community leaders or, in countries where they exist, private veterinary practitioners and ancillary veterinary staff (such as community-based animal health workers employed by government or non-governmental organizations [NGOs]).

Once a report of possible FMD has been received, the following actions must take place:

- immediate investigation of the report, including collecting specimens to confirm the diagnosis with the minimum delay;
- prevention of spread of the disease during the investigation phase;
- reporting to the appropriate national authorities;
- evaluation of the evidence by personnel with sufficient knowledge of FMD to make an informed decision as to whether to proceed to the alert phase or wind down operations.

On receiving information possibly indicating FMD, the local (field) veterinary authority should carry out an investigation by visiting the location of the index case(s) to gather information about the clinical and epidemiological features of the case, and collect specimens that may aid diagnosis. The specimens should be transmitted on ice or in 50 percent glycerosaline (if refrigeration is not available) to the nearest laboratory as soon as possible. The remaining animals should be examined. If there are sufficient grounds to suspect FMD, such immediate quarantine and movement restrictions as are within the power of the local authority should be imposed. In the absence of legal powers, every effort must be made to obtain community cooperation in preventing the movement of susceptible species livestock and their products, pending further investigation.

Depending on the size of the country and veterinary hierarchy, the line of communication from farm level to national veterinary authority may contain few or many links but, given the possibility of FMD, the report should reach the CVO or Director of Veterinary Services (DVS) as soon as possible. While investigating false
alarms at the highest level may result in some inconvenience and expenditure, the consequences of missing an index case because a person with imperfect knowledge of the disease was not sufficiently convinced may result in a catastrophe. In countries previously not infected, it is most unlikely that the index case will be the first to have occurred.

If the investigation reveals that the circumstances are not suggestive of FMD, or an alternative diagnosis can be made, a false alarm may be declared and operations may wind down. The declaration of a false alarm should always be accompanied by an expression of public gratitude to those who reported the index case, to encourage people to report suspicions of FMD without fear of being proved wrong. To control major diseases of livestock, it is most important to develop a culture of reporting any and all suspected cases.

**ALERT PHASE**

If clinical and epidemiological results are highly indicative of FMD, the main actions required are:

- prevention of spread from the identified focus of infection;
- confirmation of the diagnosis;
- identification of other possible foci;
- reporting and dissemination of information.

The CVO or DVS should therefore:

- ensure that all necessary measures are in place to enforce control at local level (i.e. quarantine of infected premises and prohibition of movement of animals, animal products, people, vehicles and fomites);
- activate the National Emergency Preparedness Plan for FMD;
- make the necessary arrangements to ensure that funds are available to cover field and laboratory investigation;
- ensure that equipment, materials and transport (vehicles and fuel) are available;
- appoint and dispatch the FMD expert team, which should include an epidemiologist, a laboratory diagnostician and a control officer, with such technical support as they may require;
- alert the police, army, customs, wildlife authority and relevant government departments (if necessary by convening a meeting of the Interministerial Committee in countries where this is a prerequisite for cooperation);
- define zones of control and observation;
- alert the chief veterinary officer in all provinces or regions in
the country (given the potential of FMD to spread rapidly over long distances);

• communicate the details of the outbreak of disease to the international authorities (OIE, FAO, the World Reference Laboratory for FMD and regional laboratories for FMD) as soon as possible.

CVOs in all neighbouring countries should be warned to be on the alert because of the potential for rapid transboundary spread before diagnosis has been confirmed, especially in continental countries with porous borders.

If national and local livestock farmers’ associations exist, alerting them to the situation as soon as possible will assist in ensuring their support and cooperation should FMD be confirmed, and will also have a beneficial effect on enforcement of local disease control measures.

The operational phase is initiated when the occurrence of FMD has been confirmed and an FMD emergency is declared in the country. Immediate actions required of the CVO are to:

• brief the appropriate minister and obtain political support for control activities;
• activate the CCEAD;
• prepare and send international disease reports to OIE, FAO and neighbouring countries;
• start a public awareness and education campaign;
• set up national and local disease control centres;
• institute national surveillance for FMD;
• establish zones and movement controls;
• obtain supplies of vaccine, disinfectants and other essential materials;
• institute stamping out and/or vaccination programmes.

If FMD is not confirmed, the CVO should inform all parties involved that the projected emergency situation has ceased to exist.

When FMD has been confirmed, the stand-down phase commences when intensive disease surveillance indicates that the control and eradication programme has been successful and there have been no reports of clinical FMD for at least two to three months. The emphasis should then be on:
Preparation of foot-and-mouth disease contingency plans

- instituting rehabilitation programmes for affected farmers and farming communities;
- obtaining verifiable scientific evidence, including the results of clinical and serological surveillance, that the disease has indeed been eradicated from an area or the whole country;
- preparing and presenting a case for freedom to OIE;
- re-establishing trade and normal farming activities;
- instituting programmes to prevent the reintroduction of FMD to free zones or the whole country;
- reviewing the control and eradication programme with all stakeholders; and
- revising the FMD contingency plan in the light of the above.
Training, testing and revision of contingency plans

Simulation exercises are extremely useful for testing and refining contingency plans in advance of any disease emergency. They are also a valuable way of building teams for emergency disease responses and training individual staff.

Realistic disease outbreak scenarios should be devised for the exercises, using real data where possible (e.g. for livestock locations, populations and trading routes). A scenario may cover one or more time phases during the outbreak, with a range of possible outcomes. However, neither the scenario nor the exercise should be too complicated or too long. It is best to test just one system at a time (e.g. operation of a Local Animal Disease Control Centre). Simulation exercises may be undertaken purely as a paper exercise or as mock activities, or combining both approaches. At the completion of each simulation exercise there should be a “post-mortem” of the results. Such a review will identify areas where plans have to be modified as well as further training needs.

A full-scale disease outbreak simulation exercise should only be attempted after individual components of the disease control response have been tested and proved. Any earlier exercise of this nature may be counterproductive. Care must be taken that simulation exercises are not confused with actual outbreaks in the minds of the media and the public. Neighbouring countries and trading partners should be warned in advance so that there are no misunderstandings.

All staff should be thoroughly trained in their roles, duties and responsibilities in an FMD emergency. More intense training will obviously need to be given to those in key positions. It should also be borne in mind that any staff member, from the CVO downwards, may be absent or may need to be relieved during a disease
emergency for one reason or another. Backup staff should therefore be trained for each position.

Contingency plans, once prepared, should not be treated as static entities but be regarded as living documents that need to be regularly reviewed and updated as warranted by changing circumstances. Plans should be reviewed at least annually and more frequently if so required. In reviewing and updating FMD contingency plans, the following factors need to be taken into account:

• changing epidemiological situations, both within the country and externally;
• new FMD threats;
• new scientific and technological developments;
• changes in livestock production systems and trade requirements (internal or export);
• changes in national legislation or in the structure or capabilities of government veterinary services (or other interested government parties);
• experiences (both within the country and in neighbouring countries), results from training or simulation exercises and feedback from major stakeholders, including farmers.
## Appendix 1

### Collaborating centres

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<tr>
<th>Centre</th>
<th>Description</th>
<th>Acronym</th>
<th>Address</th>
<th>E-mail</th>
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<td>CENTRAL VETERINARY DIAGNOSTIC AND RESEARCH LABORATORY – ZIMBABWE</td>
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<td>LCV</td>
</tr>
<tr>
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<td>Route de Koulikoro; Km 8 BP 2295 Bamako, République du Mali</td>
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<td>Dr Cheick Fanta Mady Simbé</td>
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<tr>
<td><strong>Contact person</strong></td>
<td>Dr Cheick Fanta Mady Simbé</td>
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<tr>
<th><strong>NATIONAL VETERINARY RESEARCH INSTITUTE—NIGERIA</strong></th>
<th>FAO Collaborating Centre on Emergency Preparedness for Transboundary Animal Diseases for Central Africa and Western Africa</th>
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<td><strong>Acronym</strong></td>
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<tr>
<td><strong>Address</strong></td>
<td>National Veterinary Research Institute Federal Ministry of Agriculture and Natural Resources Nigeria</td>
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<td><strong>Contact person</strong></td>
<td>Dr David Shamaki</td>
</tr>
</tbody>
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Appendix 2

OIE experts and reference laboratories/FAO reference laboratories for FMD

<table>
<thead>
<tr>
<th>OIE EXPERTS AND REFERENCE LABORATORIES FOR FMD</th>
</tr>
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<tbody>
<tr>
<td><strong>Dr D. Paton</strong></td>
</tr>
<tr>
<td>Head, World Reference Laboratory for FMD</td>
</tr>
<tr>
<td>Institute for Animal Health</td>
</tr>
<tr>
<td>Ash Road</td>
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<tr>
<td>Pirbright</td>
</tr>
<tr>
<td>Woking</td>
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An FAO Reference Laboratory provides consultations; assists in making diagnoses and develops diagnostic capability; maintains a reference collection of disease agents; produces and standardizes reagents; and assists in characterization of causative agents and in training activities.

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