

MANUAL ON THE PREPARATION OF AFRICAN SWINE FEVER CONTINGENCY PLANS

Text prepared by

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Foreword

African swine fever (ASF) is one of the most serious transboundary animal diseases because of its high lethality for pigs, its crippling socio-economic consequences and its propensity for rapid and unanticipated international spread.

Transboundary animal diseases (TADs) are defined for EMPRES (Emergency Prevention System for Transboundary Animal and Plant Pests and Disease) as those diseases that are of significant economic, trade and food security importance for a considerable number of countries, that can easily spread from one country to another and reach epidemic proportions and that require international cooperation for control and management, including exclusion. The International Office of Epizootics (OIE) International animal health code includes ASF among List A diseases, which are 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 animals products".

This manual provides information on the nature of ASF and the principles and strategic options regarding prevention, control and elimination of the disease. It provides guidelines for individual countries threatened by ASF for formulation of overall national policy on control and eradication of a possible incursion of the disease. The manual identifies the personnel, equipment and facilities needed in a national ASF contingency plan. A suggested outline of the format and contents of a national ASF contingency plan is provided; it should be modified to suit the needs and circumstances of individual countries. Consideration was given to the provisions in the OIE International animal health code in the preparation of the manual. It is suggested that this manual should be used together with the FAO Manual on the preparation of national animal disease emergency preparedness plans, published in 1999.

Sources of information recommended for use in conjunction with this manual include:

- Australian veterinary plan (AUSVETPLAN) disease strategy: African swine fever, 2nd ed. 1996. Agriculture and Resource Management Council of Australia and New Zealand.
- International animal health code: mammals, birds and bees. 1999. Paris, OIE.
- Manual on the preparation of national animal disease emergency preparedness plans. 1999. Animal health manual No. 6. Rome, FAO.
- Manual on livestock disease surveillance and information systems. 1999. Animal health manual No. 8. Rome, FAO.
- Manual on procedures for disease eradication by stamping out. To be published. Rome, FAO.
- Plowright, W., Thomson, G. R. & Nesser, J. A. 1994. African swine fever. In J. Coetzer, G. Thomson & R. Tustin, eds. Infectious diseases of livestock, with special reference to South Africa, Vol. 1, p. 568–599. Oxford, Oxford University Press.
- Recognizing African swine fever - a field manual. To be published. Rome, FAO.

This manual will be reviewed regularly and revised in the light of experience. Suggestions and recommendations for amendment should be forwarded to:

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

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Acronyms and abbreviations

AGIDT	Agar-gel immunodiffusion test
ASF	African swine fever
AUSVETPLAN	Australian Veterinary Emergency Plan
CCEAD	Consultative Committee on Emergency Animal Diseases
CIE	Counterimmunoelectrophoresis
CSF	Classical swine fever
CVO	Chief veterinary officer
DVS	Director of veterinary services
ECOWAS	Economic Community of West African States
EDTA	Ethylenediamine tetra-acetic acid
ELISA	Enzyme-linked immunosorbent assay
EMPRES	Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases
FAO	Food and Agriculture Organization of the United Nations
FVO	Field veterinary officer
IAEA	International Atomic Energy Agency
IATA	International Air Transport Authority
IF	Immunofluorescence
OAU	Organization for African Unity
OIE	International Office of Epizootics
PCR	Polymerase chain reaction
PVO	Provincial veterinary officer
SADC	Southern African Development Community
TADINFO	Transboundary animal disease information system

SUGGESTED FORMAT AND CONTENTS OF A NATIONAL ASF CONTINGENCY PLAN

An ASF contingency plan should be a well articulated strategy document designed to define actions to be taken in the event of an ASF emergency. It should contain details of the resources needed to meet such an emergency and an action plan for rapid, efficient deployment of 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, the suggested format and contents described here should serve as guidelines for national ASF contingency plans. It is suggested that a national ASF contingency plan should include the elements set out below.

NATURE OF THE DISEASE

This section should describe the essential features of ASF such as:

- aetiology;
- world evolution and distribution;
- epidemiological features;
- clinical signs;
- pathology;
- immunology;
- diagnosis: field, differential and laboratory.

While most of these aspects are generic and could be used almost unmodified, others may need to be modified to reflect the prevailing circumstances in individual countries.

RISK ANALYSIS FOR ASF

This provides information on just how serious a threat ASF is for the country in comparison with other transboundary animal diseases, where and how ASF might be present and what its potential consequences are. Risk analysis should indicate how much effort should be put into contingency planning and provide the rationale for the disease-control strategies selected.

Risk analyses need to be updated regularly to take account of changing internal and external circumstances.

PREVENTION STRATEGIES

This describes the quarantine and other measures that should be used to minimize the risk of introduction and establishment of ASF.

EARLY WARNING CONTINGENCY PLAN

This includes all initiatives to be taken to ensure that an incursion of ASF can be recognized and countered before it reaches epidemic proportions and to monitor progress of eradication campaigns. It includes 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.

STRATEGIES FOR CONTROL AND ERADICATION OF ASF

At present, the only viable strategy for eradication of ASF is by stamping out. This section, which is the core component of the contingency plan, should describe the workings of an eradication campaign based on a stamping-out policy. It must show how disease eradication should be verified and national freedom from ASF demonstrated to international standards.

ORGANIZATIONAL ARRANGEMENTS FOR ASF EMERGENCIES

The administrative structures of national veterinary services, evolved to deal with routine animal health programmes, are not necessarily appropriate for emergency disease control. This section should describe the organizational arrangements to be established when there is an ASF emergency. The aim is to enable all necessary resources to be efficiently marshalled to respond to the emergency. These arrangements will vary according to the infrastructure, veterinary services capacity and bureaucratic arrangements of individual countries.

SUPPORT PLANS

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

ACTION PLANS

These are mechanisms whereby the 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 and e-mail addresses of the following should be included in appendixes to the contingency plan:

- regional and world reference laboratories for ASF;
- international organizations for possible assistance.

Information on national animal health laws and other data relevant to a particular country should be included.

It should be emphasized that what follows provides only the framework for national contingency plans for ASF. Countries must take account of their particular circumstances.

NATURE OF THE DISEASE

DEFINITION

A highly contagious viral disease of domestic pigs, ASF manifests itself as a haemorrhagic fever and results in up to 100 percent mortality. The catastrophic effect of this disease on pig production, from household to commercial level, has serious socioeconomic consequences and implications for food security. It is a serious transboundary animal disease with the potential for rapid international spread.

WORLD DISTRIBUTION

First described by Montgomery in 1921 in Kenya, ASF has subsequently been reported from most countries in southern and eastern Africa, where the virus is maintained either in a sylvatic cycle between warhogs (*Phacochoerus aethiopicus*) and ticks of the *Ornithodoros moubata* complex or in a domestic cycle that involves pigs of local breeds, with or without tick involvement. Countries where endemicity is confined to the sylvatic cycle include Kenya, Namibia, Botswana, Zimbabwe and northern South Africa. A cycle in domestic pigs apparently occurs in Angola, the Democratic Republic of the Congo, Uganda, Zambia, Malawi, northern Mozambique and probably the Congo (Brazzaville), Rwanda, Burundi and Tanzania. Madagascar experienced ASF for the first time in 1997–98; it caused serious losses and has not yet been eradicated.

The disease spread to Portugal in 1957, almost certainly from Angola. Although it was apparently eradicated, a second introduction in 1959 resulted in spread throughout the Iberian peninsula and to several other countries in Europe, including France, Italy, Malta, Belgium and the Netherlands. ASF became well established in Spain and Portugal, where eradication was only accomplished in the early 1990s and remains endemic on the Italian island of Sardinia. Portugal experienced an outbreak in late 1999, which was evidently rapidly contained.

In 1977, ASF spread to Cuba, where it was eradicated with the loss of some 400 000 pigs. Outbreaks occurred in Brazil and the Dominican Republic in 1978, Haiti in 1979 and Cuba in 1980. Eradication from these countries was achieved only by massive depopulation of pigs. Whether these outbreaks originated in Europe or Africa has never been established.

In West Africa, ASF has been endemic in Cameroon since the first reported outbreaks in 1982. It is endemic in southern Senegal, the Gambia and probably Guinea Bissau and the islands of Santiago and Maio in the Republic of Cabo Verde. The disease has been present in this focus since at least 1958–60. An outbreak of ASF occurred in Nigeria in 1973. In 1996, Côte d'Ivoire experienced a massive outbreak that spread rapidly through the southern parts of the country. The last focus was extinguished by October 1996. In October 1997, ASF was reported in Benin, rapidly followed by Togo and two western provinces of Nigeria. Spread in these countries was rapid. In October 1999, ASF was reported in Ghana. Rapid implementation of control measures has apparently been successful, as no ASF has occurred since February 2000. Because of civil unrest in various regions and lack of disease reporting from some countries, the ASF status of a number of countries in Africa is unknown. All of the countries in sub-Saharan Africa that have significant pig populations must be considered to be infected, potentially infected or at risk from ASF.

AETIOLOGY

The cause of ASF is a unique DNA virus that was formerly classified in the family Iridoviridae because of morphological similarities. Now considered to be more akin to members of the Poxviridae, it is currently the sole member of a family of ASF-like viruses, the Asfaviridae. It is unusual among the DNA viruses in behaving as a true arbovirus, able to multiply in both vertebrate and invertebrate hosts. There is a single serotype. Using restriction length fragment polymorphism

and nucleotide sequencing techniques, numerous strains of ASF virus of varying virulence have been detected.

EPIDEMIOLOGICAL FEATURES

Susceptible species

Only species of the pig family (Suidae) are susceptible to infection with ASF virus. Domestic pigs are highly susceptible to ASF, which shows no breed, age or sex preference. Certain populations of pigs of local races in central Africa demonstrate a higher-than-expected survival rate during ASF outbreaks. A high proportion of the pigs in these populations are serologically positive for ASF and apparently healthy. This suggests that these pigs, which are derived from pigs introduced into Africa some 400–500 years ago, probably from the Iberian peninsula, may have a degree of genetic resistance to the virus.

All wild African suids are susceptible to infection with the virus but do not develop clinical disease. Warthogs are the major host for ASF virus. Bushpigs (*Potamochoerus porcus* and *P. larvatus*) and giant forest hog (*Hylochoerus meinertzhageni*) have been found to be infected with ASF virus but the extent of infection and their role in the epidemiology of the disease are unknown.

European wild boar (*Sus scrofa*) are fully susceptible to ASF, with a mortality rate similar to that of domestic pigs. Feral pigs in the American region, probably partially derived from European wild boar, have been shown to be highly susceptible to experimental infection, as have farmed descendants of European wild boar and domestic pigs in South Africa. The susceptibility of other wild suids in areas where ASF does not occur has not been investigated, with the exception of the collared peccary (*Tayassu tajacu*), which proved completely resistant.

Human beings are not susceptible to ASF.

Virus survival

In the environment. ASF virus, in a suitable protein environment, is stable over a wide range of temperature and pH. It has been shown to survive in serum at room temperature for 18 months, in refrigerated blood for six years and in blood at 37°C for a month. Heating at 60°C for 30 minutes will inactivate the virus. In the laboratory, ASF virus remains infective indefinitely at - 70°C but may be inactivated if stored at - 20°C. In the absence of a protein medium, viability is greatly reduced. ASF virus is generally stable over a pH range of 4–10 but in a suitable medium (serum) has been shown to remain active at lower and higher values for between a few hours and three days. Putrefaction does not necessarily inactivate the virus, which may remain viable in faeces for at least 11 days, in decomposed serum for 15 weeks and in bone marrow for months. On the other hand, culture of virus from decomposed samples is frequently unsuccessful. As a result of its tolerance to a wide range of environmental factors, only certain disinfectants are effective in the control of ASF.

In the host. After infection with ASF virus, domestic pigs may shed infective amounts of virus for 24–48 hours before clinical signs appear. During the acute stage of disease, enormous amounts of virus are shed in all secretions and excretions and high levels of virus are present in tissues and blood. Pigs that survive the acute disease remain infected for several months but do not readily shed virus for more than 30 days. As in wild suids, infective levels of virus are found only in lymph nodes; other tissues are unlikely to contain infective levels of virus for more than two months after infection. The exact length of time over which infective levels of virus are maintained in lymphoid tissues in either wild suids or domestic pigs is unknown and is probably subject to considerable individual variation.

In animal products. The ability of ASF virus to remain infective in edible products such as chilled meat (at least 15 weeks) and three to six months in processed hams and sausages that have not been cooked or smoked at a high temperature has important implications for spread of ASF. Undercooked pork, dried and smoked pork and carcass meal derived from pigs must be regarded as potentially dangerous if fed to pigs.

Disease transmission. In the sylvatic cycle between warthogs and argasid ticks of the *Ornithodoros moubata* complex, transmission occurs between ticks and neonatal warthogs, among ticks and between ticks and domestic pigs. Adult warthogs, even if they have infective levels of ASF virus in lymph nodes, do not shed virus or develop viraemia sufficient to permit infection of ticks that feed on their blood. It has been demonstrated that transmission of ASF virus between ticks and warthogs probably occurs exclusively during the first four to six weeks of life, when the young warthogs spend most of their time in the burrows, which are inhabited by large numbers of ticks. Infected ticks feeding on baby warthogs transmit infective levels of virus in their saliva, which acts as an anticoagulant, to cause viraemia in the warthogs sufficient to infect other ticks. Even at this stage, the young warthogs show no signs of disease. Among ticks, ASF virus is transmitted transovarially, transstadially and sexually from males to females via the spermatheca. Although *Ornithodoros* spp. generally feed rapidly and drop off the host, relatively large numbers of particularly nymphal ticks have been found on warthogs shot far from their burrows. Transmission to domestic pigs from warthogs is believed to occur mostly via infected ticks that drop off warthogs in their vicinity. Since warthogs inhabit savannah regions that are generally fairly dry, they are attracted to the food and water sources available to domestic pigs. Transmission via feeding the remains of warthogs to pigs is frequently suggested as the source of an outbreak but this has proved difficult experimentally. The sylvatic cycle predominates in eastern and southern African countries where warthogs and *Ornithodoros moubata* occur and where pig production is at a low level or of a modern, intensive nature. Although warthogs occur widely in the savanna areas of West Africa, the presence of *Ornithodoros* ticks has not been demonstrated and the outbreaks have occurred outside the warthog distribution areas. Because of excessive hunting, bushpigs are regarded as virtually extinct and therefore an unlikely reservoir for ASF virus.

The endemic cycle in domestic pigs that occurs over large parts of central Africa has not been fully elucidated. In some areas, particularly in Malawi, ticks of the *Ornithodoros moubata* complex, which inhabit human dwellings and the shelters in which pigs are kept at night, are involved in a cycle of transmission to domestic pigs that have a higher than expected survival rate. In other areas, the occurrence of *Ornithodoros* has not been proven. In the Iberian peninsula, *Ornithodoros erraticus* contributed significantly to ASF endemicity. This species occurs in North Africa as far south as Dakar but has not been shown to occur in the Gambia, southern Senegal, Cabo Verde or Sardinia. A number of species of *Ornithodoros* that occur in the Caribbean and North America are capable of maintaining and transmitting ASF virus but ticks were apparently not involved in the Caribbean outbreaks of ASF. Although carrier pigs apparently shed virus for only short periods after infection and although transmission by feeding of tissues from chronically infected animals is apparently short-lived, some mechanism must exist for the maintenance and transmission of disease in domestic pigs where the tick vectors do not occur. Investigation of large numbers of ectoparasites-including pig lice, mange mites and ticks other than *Ornithodoros* that feed on pigs, such as *Rhipicephalus*- has revealed their inability either to maintain ASF virus or transmit it mechanically. Only stable flies of the genus *Stomoxys* have been shown to maintain and transmit infective levels of virus for 24–48 hours.

During an epizootic, transmission is by direct contact between infected pigs and their secretions and excretions. Infection generally occurs via the oronasal route. Aerosol transmission has been shown to occur only over very short distances. Spread via fomites - contaminated vehicles, equipment and clothing - is likely when there are high levels of environmental contamination. Iatrogenic spread via contaminated needles is likely, as attempts may be made to vaccinate against classical swine fever (CSF) or to treat for bacterial diseases such as erysipelas without inadequate sterilization or replacement of needles. Although waste disposal is often via rivers and other bodies of water, waterborne transmission is most unlikely because of dilution of the virus. When waterways are used for disposal of carcasses, however, transmission through carrion feeding is highly likely. It has been shown that pig sties in tropical countries do not remain infective for more than three to four days, even in the absence of cleaning and disinfection, but high levels of ASF virus may persist in protein-rich, moist environments such as slurry.

FIGURE 1



Scavenging animals

Scavenging animals are major concern during an emergency disease outbreak, because they can catch and/or spread disease easily.

Swill feeding, in particular swill originating from aircraft and ships, has been incriminated as a major source of infection. Swill that consists of or contains large amounts of infected pork has a high potential for spreading infection and has probably contributed to many of the outbreaks that have occurred. Scavenging of offal and remnants of infected pork discarded during preparation for human consumption is probably more significant in areas where national dishes are subjected to lengthy cooking. When an outbreak occurs, large amounts of infected pork become available as pigs die. Surplus meat may be dried or subjected to other processes that do not inactivate the virus and pigs are moved rapidly in attempts to avoid disease and evade uncompensated compulsory slaughter. It is likely that in Africa, at least, the potential to move live pigs infected over long distances is grossly underestimated. The incubation period varies from 5 to 15 days. Clinical disease is usually peracute or acute. Subacute or chronic manifestations of ASF may occur, particularly when less virulent strains are involved, but have rarely been described in Africa.

High mortality among pigs of all ages is a major indicator for ASF.

CLINICAL SIGNS

Peracute ASF

Pigs are usually found dead without premonitory signs. Recumbency, accompanied by high fever, indicated by flushing of the ventral area and extremities in white-skinned pigs, shade seeking, huddling together and rapid shallow breathing may be observed in some animals before death.

Acute ASF

Pigs develop a persistent fever of up to 42°C. They become listless and anorexic, huddle together, seek shade and sometimes water and are reluctant to move. White-skinned pigs become flushed to cyanotic, particularly the ears, lower legs, and ventral abdomen. Mucopurulent ocular and nasal discharges may be evident. Signs of abdominal pain such as arching of the back, uncomfortable movements and flank kicking may occur. Vomiting is common and pigs may develop either constipation, with hard small faeces covered in blood and mucus, or bloody diarrhoea, with soiling of the tail and perineum. Ataxia due to hind-limb weakness usually develops. Difficult breathing,

sometimes with froth that may be bloody at the mouth and nostrils, often occurs and is indicative of the lung oedema that is often the primary cause of death. Pigs that survive longer may develop nervous signs, including convulsions. Pinpoint to larger haemorrhages may be visible on the mucosa and skin. Abortions may occur at any stage of pregnancy. Duration of clinical signs is generally short - two to seven days - but may be longer and apparent recovery may be followed by relapse and death. Mortality approaches 100 percent. Pigs that do recover from acute infection are generally asymptomatic. Subacute and chronic forms of ASF were common in Europe and the Caribbean but are rarely seen in Africa, although there are early descriptions of chronic disease in Angola.

Subacute ASF

Pigs that survive longer, usually after infection with less virulent strains, may have a fluctant fever and usually lose condition. An interstitial pneumonia is usually present, which may result in respiratory distress and moist coughing. Secondary bacterial infection may occur. Joints may be painful and swollen. Death may occur after a variable period of weeks to months, or the pigs may recover or progress to the chronic form of the disease. Cardiac damage may result in death from acute or congestive heart failure.

Chronic ASF

Chronically infected pigs are usually severely emaciated and stunted, with a long dull hair coat. Signs of pneumonia may be present, as well as lameness and ulcers over bony points. These pigs are subject to secondary bacterial infections. They may survive for several months but recovery is unlikely.

PATHOLOGY

Gross Pathology

Pigs that die of peracute ASF may show few gross lesions, apart from the blood splashing and mild accumulation of fluid in body cavities that usually accompany sudden death.

In acute ASF, the carcass is often in good condition. In white-skinned pigs, the extremities and the ventral surface may be cyanotic and subcutaneous haemorrhage may be evident. Mucosa are often congested to haemorrhagic. When the carcass is opened, straw-coloured to blood-coloured fluid may be present in body cavities. Organs are generally congested and haemorrhages may be evident over serosal surfaces. Pinpoint haemorrhages are often present in the renal cortex, over the splenic capsule and in the lungs, with larger haemorrhages often occurring on the epi- and endocardium and on the gastro-intestinal serosa. The spleen is slightly to considerably enlarged, soft and dark, with rounded edges. Peripheral infarcts may be present; in these cases the spleen is generally only moderately enlarged. Lymph nodes, particularly the gastrohepatic, mesenteric, renal and submandibular lymph nodes, are enlarged and severely haemorrhagic; they often resemble blood clots. The mucosa of the stomach is often deeply congested to haemorrhagic and sometimes necrotic; haemorrhage may be present in the gall bladder and the urinary bladder. The lungs do not collapse and are enlarged due to the accumulation of fluid, so that interlobular septa are prominent. Fluid and froth ooze on cut surfaces and the trachea is often filled with froth, which may be bloody.

The main features of subacute and chronic ASF are loss of condition to emaciation, interstitial pneumonia and enlarged lymph nodes, which may be firm and fibrous in the chronic form of the disease.

Histopathology

Pathological changes are ascribed to the effects of the virus on macrophages, which result in massive destruction of these cells accompanied by release of cytokines. The most striking histopathological feature of ASF is massive karyorrhexis in lymphoid tissues, often accompanied by haemorrhage. The S-S (Schweiger-Seidel) sheaths of the spleen are virtually obliterated. Blood vessel walls, especially in the lymphoid tissues, often exhibit fibrinoid change resulting from necrosis of the endothelium and leakage of inflammatory mediators. Other changes include

interstitial pneumonia with accumulation of fibrin and macrophages, renal tubular degeneration with hyaline droplet absorption, infiltration of portal tracts in the liver with macrophages and lymphocytic meningoencephalitis.

IMMUNITY

Antibodies against ASF are detectable in serum 7–12 days after clinical signs appear and persist for long periods, possibly for life, in both warthogs and domestic pigs. They do not protect fully against subsequent infection in domestic pigs, although a degree of immunity to infection with homologous strains of virus has been reported. Serologically positive sows transmit antibodies to piglets in colostrum. In subacutely and chronically infected pigs, virus replication continues in the presence of antibodies. The deposition of immune complexes in tissue may account for many of the lesions observed in these forms of disease.

Since no vaccine is available for ASF, the detection of antibodies in pigs can be confidentially attributed to exposures to natural infection. There are no known serological cross-reactions with other viruses.

DIAGNOSIS

Field diagnosis

Unusually high mortality among pigs of all age groups should lead to a strong suspicion of ASF. Additional indicators are the typical clinical signs and lesions of ASF, failure to respond to antibiotic treatment and the fact that no other livestock species are involved. There are relatively few serious diseases of pigs that affect other species and the omnivorous habits of pigs make it likely that they will be the first victims of malicious or accidental poisoning. Laboratory confirmation of ASF is essential.

Differential diagnosis

Hog cholera, or CSF, is the most important differential diagnosis for ASF. Clinical signs and gross lesions may be identical and such minor differences as have been described are not pathognomonic or consistent. Lesions such as button ulcers at the ileocaecal junction described in CSF are far from frequent and splenic infarction possibly has a similar incidence in both diseases. Laboratory diagnosis is therefore absolutely essential in any case of suspected swine fever.

Several other diseases that may be confused clinically with ASF are given below.

- Bacterial septicaemic diseases such as erysipelas, pasteurellosis and salmonellosis generally have a predilection for a particular age group, have a lower incidence and mortality rate, respond to treatment with appropriate antimicrobials and can be confirmed on bacterial and histopathological examination. Anthrax in its acute, systemic form may be considered as a differential diagnosis, although in pigs this disease usually appears as the Pharyngeal form, which is distinctive and has little in common with ASF.
- Warfarin poisoning, through ingesting rat poisons, causes severe haemorrhage and death; only a few pigs in a herd would be likely to be affected, however.
- Fungal poisonings caused by eating mouldy feed, such as aflatoxicosis and stachybotryotoxicosis, may cause haemorrhage, severe mortality and, in the case of stachybotryotoxicosis, marked karyorrhexis in lymphoid tissues. Although these can cause mortality in any age groups, particular groups of pigs are usually exposed, since different age groups usually receive different rations. Confirmation requires analysis of the feed by sophisticated techniques.
- Trypanosomiasis, carried by tsetse flies, causes severe mortality in pigs of all ages. Death caused by *Trypanosoma suis* generally occurs before anaemia (lack of blood, indicated by pallor) and icterus (jaundice) develop. The parasite is easily demonstrated on blood smears stained with Giemsa or Romanoff stains. The severity of this disease is such that pig production in areas where the parasite occurs is generally not possible, so in practice it is an unlikely differential diagnosis.

FIGURE 2



Sampling

Taking blood samples, seen here in Cabo Verde in 1999, is a routine necessary in ASF diagnosis and surveillance.

Cases of subacute and chronic ASF are difficult to distinguish from other causes of pigs failing to thrive; if these are caused by strains of lower virulence, diagnosis may be very difficult. If they are simply manifestations of disease in surviving pigs, the herd history should indicate that high mortality with appropriate clinical signs and lesions occurred in the herd.

Laboratory diagnosis

Laboratory confirmation of a presumptive diagnosis of ASF depends upon detection of the virus or detection of antibodies. Since most pigs die of acute ASF before antibodies are produced, detection of the virus is the most important method of diagnosis. Detailed instructions for laboratory diagnostic procedures for ASF are to be found in the OIE *Manual of standards for diagnostic tests and vaccines*. The following is a summary, with the emphasis on tests that are usually used.

Collection and transport of diagnostic specimens. Preferred samples for virus isolation/antigen detection are:

- tissue samples from lymph nodes, spleen and tonsils collected aseptically and kept chilled but not frozen;
- whole (unclotted) blood collected aseptically into ethylenediamine tetra-acetic acid (EDTA) or heparin (purple-or green-topped tubes) from febrile pigs up to five days after the onset of fever.

To detect antibodies, blood samples should be collected in red-topped tubes (i.e. without anticoagulant). Various methods of collecting blood using filter paper strips or capillary tubes are available but in practice these samples are difficult to handle correctly.

A range of tissues - spleen, lymph nodes, lung, liver, kidney and brain- may be collected in 10 percent buffered formalin for histopathological examination and detection of virus by immunoperoxidase.

Whole blood and unpreserved tissue samples should be chilled and transported on water ice or frozen gel packs. If a break in the cold chain is likely or chilling is primarily impossible, the addition of 50 percent glycerosaline will provide adequate preservation while enabling viral culture. The addition of antibiotics - 200 units of penicillin and 200•g/ml streptomycin - will prevent bacterial growth. The addition of formol-glycerosaline will permit detection of viral DNA but will not permit culture. Freezing is not recommended if culture is intended, as ASF virus may be inactivated at - 20°C.

Serum samples should be centrifuged if possible or the clot removed before transport. After collection, blood samples destined for serology should be allowed to stand at room temperature for at least sufficient time for clotting before refrigeration. If the tubes are placed stopper-down, the blood clot can easily be removed with the stopper, and the stopper then replaced. The samples are then submitted on ice as described for tissue samples or they may be frozen.

Unpreserved diagnostic samples should be placed in a strong watertight container, generally a plastic screw-topped jar or, in the case of blood or serum, a vacutainer. This is wrapped in absorbent material, placed in a strong leakproof secondary container, usually a plastic or styrofoam cold-box, and finally in a solid outer covering. The package is then labelled with waterproof ink for despatch to a national or international reference laboratory. If samples are being transported in hot climate conditions from the field to a national laboratory, it is advisable to acquire a cold-box. Ice may be available in villages; if ice is not available, bottled refrigerated drinks or chilled plastic bags of water for drinking can be used to provide additional cooling in the box during transport. When samples are sent by air, International Air Transport Authority (IATA) rules should be followed. Information about the carrier, airway bill number and time of arrival should be sent ahead to the laboratory.

All specimens should be accompanied by basic information: name of owner, locality, brief history (number and dates of pig deaths, ages of pigs, clinical signs), date of collection, disease suspected and tests required. If several samples are submitted, each should be labelled or given a number in waterproof ink referring to the accompanying information. Laboratory diagnosis should only be attempted by trained personnel in well equipped laboratories.

FIGURE 3



Diagnostic capacity

It is essential to have appropriate diagnostic capacity during emergency disease outbreaks, in order to identify the causative agent(s) immediately.

Virus isolation. Isolation should only be attempted in well equipped laboratories in countries where pigs guaranteed free of ASF are readily available, in order to obtain the materials and resources to maintain capacity in the absence of field samples.

ASF virus may be isolated by the methods given below.

- Inoculation of primary pig leucocyte cell cultures and subsequent identification of ASF virus by haemadsorption and cytolitic effect, which may be confirmed by other tests such as fluorescent antibody tests.
- Inoculation of pigs. Pigs are monitored daily for febrile reactions and fresh tissues are collected from pigs that die or are euthanized for virus isolation. It has been recommended that two groups of pigs, one of which has been vaccinated against CSF, should be used in order to distinguish between the two diseases. However, the advent of more rapid, specific tests to detect ASF virus antigen or DNA are likely to have been applied first to obtain a diagnosis and the main purpose of culture is to confirm viability of the virus and obtain optimal material for strain identification. CSF will therefore already have been excluded.

Antigen detection. The following tests may be used:

- fluorescent antibody test;
- immunoperoxidase staining of histopathological specimens; this is not the test of choice, as preparation takes at least 24 hours and it can only be done in a reference laboratory with the capacity to perform histopathology; it is, however, useful if the only specimens available have been preserved in formalin.

Detection of viral genetic material. A polymerase chain reaction (PCR) test is available for ASF. PCR is a highly sensitive and specific technique but because of the possibility of cross-contamination, its use is in practice confined to laboratories that have this capacity for other diseases and a considerable degree of sophistication. Expense is another factor.

Antibody detection. Serological tests for ASF include:

- enzyme linked immunosorbent assay (ELISA), the most commonly used test and the prescribed test for international trade because of its superior sensitivity and specificity;
- indirect fluorescent antibody test;
- immunoblotting;
- counter-immuno-electrophoresis test; the test of choice before ELISA was developed, now completely superseded by that test.

RISK ANALYSIS FOR ASF

INTRODUCTION

Risk analysis is something we all do intuitively in our everyday life and professional activities. Only recently has it developed into a more formal discipline that is used increasingly in many fields of endeavour. In animal health it has perhaps been most widely applied in quarantine. Quarantine risk analyses are used to help determine strategies for quarantine operations and appropriate health conditions for imported animals and animal products.

Risk analysis is a tool that can be advantageously used in animal disease emergency preparedness planning. In this context, it is most readily applied to preparedness planning for exotic diseases or exotic strains of endemic disease agents. There is no reason, however, why it could not be applied for other animal health emergency planning.

PRINCIPLES OF RISK ANALYSIS

Risk analysis comprises three components. These are risk assessment, risk management and risk communication.

Risk assessment

In this component, the risks of an event occurring or of a particular course of action are first identified and described. The likelihood of those risks occurring is then estimated. The potential consequences of the risks are evaluated and used to modify the assessment of the risk. For example, an exotic disease with a high risk of entry to a country would get a low overall score on a risk assessment if there were only a low risk of its becoming established or only minor potential socio-economic consequences for the country. Conversely, a low risk of introduction but high consequent disease would be rated higher.

The assessment of risks can be done in a quantified, semi-quantified or qualitative way. It is inherently difficult to quantify or put probability numbers to risk in many biological systems, because of the lack of historical precedents and serious gaps in available biological data. It is recommended that qualitative risk assessments be used for exotic diseases. The risks can be described as extreme, high, medium or low, or scored on a simple scale of, for example, 1–5 for the level of risk and 1–5 for the level of potential consequences.

Risk management

This is the process of identifying, documenting and implementing measures to reduce the risks and their consequences. Risk 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. In fact, the whole of this manual could be regarded as providing the risk management framework for ASF 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, everyone from farmers to politicians. It is important that risk assessment and risk-management strategies be fully discussed with such people, so that they feel assured that no unnecessary risks are being taken and that 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 process of risk analysis so that risk-management strategies address stakeholder concerns and decisions are fully understood and supported.

WHO SHOULD CARRY OUT THE RISK ANALYSES?

The risk-assessment component would best be carried out by the epidemiological unit in the national veterinary headquarters as part of the national early-warning system for TADs and other emergency diseases. Risk management and risk communication are tasks for everyone but they should be coordinated by the chief veterinary officer (CVO). It should be remembered that risks do not remain static. They will change with such factors as evolution and spread of epidemic livestock diseases internationally, emergence of new diseases, changing international trading patterns for the country and so on. Risk analysis should not be seen as a once-only activity. It should be repeated and updated regularly.

RISK ASSESSMENT FOR ASF

As described above, risk assessment consists of identifying the risks, assessing the likelihood of them being realized and modifying them by evaluation of their potential consequences.

The international status and evolution of outbreaks of ASF 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 services. Apart from the scientific literature, the most valuable source of information would be from OIE, through publications such as their weekly disease reports and annual *World animal health* and by interrogation of the OIE Handistatus database. Disease intelligence is also available from FAO, including the *EMPRES Transboundary animal diseases bulletin*, which is published quarterly and is available at <http://www.fao.org/empres> on the Internet.

The Internet server and mailing service Promed currently provides a useful forum for rapid dissemination of official and unofficial information on animal, plant and human disease occurrences around the world. Animal Health Net is another useful source of information.

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 and the routes and mechanisms by which it may enter. There are various factors to be taken into account.

What is the current geographical distribution and incidence of ASF around the world?

Is the distribution fairly static or has there been a recent history of spread to new countries, regions or continents?

How close is the disease? What is the status of neighbouring countries regarding known presence of ASF and confidence in the ability of their veterinary services to detect and control outbreaks of the disease?

If it is present in neighbouring countries, where are the outbreaks nearest to shared borders?

Is there a past history of introduction of ASF to the country? Is it possible that it is still present in undetected endemic pockets of infection in domestic, feral or wild pigs?

How is the disease spread? What are the roles of live animals, genetic material, pig meat or other animal products, ticks and migrating animals in transmitting the aetiological agent?

Are there significant imports of animal species, meat products or other materials with a risk factor for ASF? 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 quarantine procedures to prevent unlawful entry of risk materials for ASF?

Is swill feeding of pigs a common practice in the country? Are there adequate procedures for making this practice safe?

Are there smuggling, unofficial livestock movements, transhumance or nomadism practices which would constitute a risk for entry of ASF? In particular, is there civil unrest in neighbouring countries that might result in major movements of people and movement or abandonment of livestock?

The next step is to evaluate how serious the socio-economic consequences might be if there is an incursion of the disease. Again there are various factors to be considered.

- Is the disease likely to become established in the country? Are there susceptible animal host populations?
- Will it be difficult to recognize the disease quickly in different parts of the country?
- How big are the domestic pig populations in the country? How important is the pig industry to the national economy? What is its importance in satisfying nutritional and other community needs?
- How is the pig industry structured within the country? Is there a large commercial pig production industry or does it consist mainly of backyard/village production? Is production concentrated in just a few areas of the country?
- How serious will production losses be from the disease? Will food security be threatened?
- What effect would the presence of the disease have for export trade of animals and animal products? What effect will it have on internal trade?
- Are there populations of wild suid species, feral pigs or domesticated pigs that are poorly controlled and allowed to roam freely? Might these constitute reservoirs of ASF infection that are difficult to control?
- Are *Ornithodoros* spp. ticks, which may allow sylvatic or domestic cycles of infection to become established, present in the country?
- How difficult and costly will the disease be to control and eradicate? Is it capable of eradication?

Addressing these questions and issues will enable analysts to build up a risk profile for ASF and make judgements in qualitative terms as to the magnitude of the risk presented by the disease. Most important, it will be possible to get an idea of how ASF ranks in relation to other high-priority disease risks and what resources should be devoted to preparedness for ASF in comparison with other diseases. It will also be possible to get some idea of where the pressure points may be for entry of the diseases and how veterinary services and contingency planning for ASF may need to be strengthened.

THE VALUE OF RISK ASSESSMENTS FOR ASF

The type of risk assessment that has been described will be of value for:

- determining how ASF 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;
- determining where and how quarantine protocols and procedures need to be strengthened;
- determining how laboratory diagnostic capabilities need to be strengthened;
- planning training courses for veterinary staff and farmer-awareness and publicity campaigns;
- determining how and where active disease surveillance needs to be strengthened;
- planning disease-response strategies.

PREVENTION STRATEGIES FOR ASF

INTRODUCTION

The old maxim that prevention is better than cure is particularly relevant to dealing with ASF and other TADs. Quarantine is the first line of defence against these diseases. All countries should devote an appropriate level of resources to ensure that they implement effective border and import quarantine policies to prevent the introduction of serious livestock diseases.

Risk analyses for ASF should provide an estimate of:

- the degree of risk of introduction of the disease;
- the likely mechanisms and portals of ASF entry;
- the potential seriousness of the consequences should the disease enter the country.

This should provide the basis for designing and implementing appropriately resourced preventive strategies for ASF.

The most important resource in the prevention of ASF or other livestock disease is the informed animal owner or manager. Pig owners at all levels of production must be able to recognize ASF and know what to do when they suspect it. This can only be achieved by intensive farmer training, using media that are easily understood, highly visual and that will serve as a constant reminder of the disease and its importance. Lines of communication must be established between livestock owners and the veterinary services. Local authorities and agricultural personnel, who must be informed about ASF, should be used as intermediaries when necessary. It has been pointed out that the only people who see animals every day are their owners. Informed owners therefore constitute the only really viable surveillance resource for animal disease.

IMPORT QUARANTINE POLICY

The OIE *International animal health code* (1999 edition, Chapter 2.1.12) provides guidelines for the safe importation of domestic and wild pigs, pig meat and meat products, pig semen, embryos and ova and other products incorporating pig tissues, such as pharmaceuticals.

BARRIER AND BORDER QUARANTINE POLICY

Attention should be paid to providing adequate quarantine services to intercept foodstuffs and other risk materials containing pig meat or products being brought into the country at international airports, seaports and border crossing points. Any confiscated quarantine risk materials should be disposed of safely by deep burial or incineration, as should all food waste from international aircraft and ships.

SWILL FEEDING CONTROLS

Swill feeding of food scraps, which may contain imported animal products, is a very important means by which ASF and other serious transboundary animal diseases such as foot-and-mouth disease (FMD), swine vesicular disease and CSF may be introduced into a country. Consideration should therefore be given to placing a ban on swill feeding or at least implementing controls that will make it safe. Every effort should be made to prevent swill feeding of food waste from international aircraft or ships, as this constitutes a high risk for introduction of ASF to new countries. There is a high probability that ASF was introduced into Latin America at least once in this way.

A ban on swill feeding is highly desirable from the point of view of disease prevention. But such a ban would be impossible to monitor at household level, which makes it difficult to achieve in many countries. For many pig producers in rural, peri-urban and urban situations, economic

circumstances dictate that any affordable food source should be used. In urban and peri-urban situations where many poor people depend on their pigs for extra income, this food is likely to come from a variety of sources, almost inevitably on a sufficiently informal basis to be beyond the reach of the law. The only possible way to avoid the problem is for pig owners to understand the dangers and to opt voluntarily to boil swill before feeding it to their pigs. Where poverty prevails, the law is usually no deterrent. Awareness of risk and a practical means to overcome it will ensure compliance with regulatory measures. In countries with a developed pig industry, it is possible that farmers will be guided by the law and banning swill feeding might offer protection. It is likely, however, that farmers at the level where the law will be adhered to would not feed swill, because they would appreciate that this type of feeding does not achieve the best results in terms of modern production.

CONTAINMENT OF PIGS

The presence of large numbers of uncontrolled or poorly controlled pigs constitutes a high risk for the entry and rapid spread of ASF. There may be significant delays in recognition of the disease and eradication will be more difficult. Perhaps the greatest danger is that these pigs have access to the carcasses of dead pigs in the bush or on garbage dumps and the offal of pigs that have died of ASF and been prepared for human consumption. Measures should be taken to encourage development of properly constructed pig pens and to reduce the numbers of scavenging pigs, particularly in areas which are considered to be at high risk for entry of ASF. Pig farmer groups at all levels should speed up the process of commercialization, encouraging the establishment of pigfarming organizations. It must be accepted, however, that traditional ways of keeping pigs in many developing countries will not be changed overnight and that permanent confinement of pigs imposes feeding obligations 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. Until more research has been done on alternative feeds, many producers will not find it worthwhile to confine their pigs. In some 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 carcasses, offal and remnants of dead pigs on garbage dumps where pigs scavenge. A national policy for upgrading pig production that includes identifying sources of cheap feedstuffs should be put in place.

Chapter 5

Early warning contingency planning for ASF

INTRODUCTION

Early warning enables rapid detection of the introduction or sudden increase in the incidence of a serious disease such as ASF before it develops to epidemic proportions and causes serious socio-economic consequences. It is based on disease surveillance, reporting and epidemiological analysis, leading to improved awareness and knowledge of the distribution and behaviour of disease outbreaks and infection. It enables forecasting of the source and evolution of the 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 ASF depends on the following:

- good awareness programmes for ASF and other high-threat epidemic livestock diseases, which involves improving communication between veterinary officers and farmers;
- training of field veterinary officers, veterinary auxiliary staff, agricultural extension officers, local authorities and pig owners in the clinical and gross pathological recognition of ASF and other serious epidemic livestock diseases;
- prompt collection and transportation of diagnostic specimens;
- sustained active disease surveillance supplementing passive monitoring, based on close coordination between pig owners, field and laboratory/epidemiology veterinary services, using participatory questionnaires, serological surveys and abattoir monitoring to supplement field searches for clinical disease;
- dependable emergency disease reporting mechanisms to regional, national or federal veterinary headquarters;
- implementation of an emergency disease information system such as TADInfo;
- enhancement of laboratory diagnostic capabilities for ASF in veterinary laboratories;
- development of links between national laboratories and regional and world reference laboratories;
- strengthening national epidemiological capabilities to support emergency preparedness and disease management;
- prompt and comprehensive international disease reporting to OIE.

It is beyond the scope of this manual to discuss these issues in detail. For more information, reference should be made to the FAO *Manual on the preparation of national animal disease emergency preparedness plans* (FAO *Animal health manual* No. 6) and the FAO *Manual on livestock disease surveillance and information systems* (FAO *Animal health manual* No. 8).

TRAINING OF VETERINARIANS AND OTHER ANIMAL HEALTH STAFF IN EARLY RECOGNITION OF ASF AND COLLECTION AND DISPATCH OF DIAGNOSTIC SPECIMENS

It is likely in many countries that few veterinarians or other animal health workers in the public or private sectors will have had any firsthand experience with ASF or other TADs. These diseases may never have occurred in the country or may have been exotic for a considerable period. If ASF is rated as a high-threat disease, this deficiency needs to be rectified by a training programme for all personnel who may be the first to come into contact with an incursion or outbreak of this disease. Because a disease may strike in any part of the country and because of staff turnovers, training programmes should be comprehensive and regular. This training must extend to staff in the remotest parts of the country as well as to agricultural extension officers, local authorities and pig owners.

It will obviously be neither practicable nor necessary to train personnel to a high level of expertise in these diseases. It is sufficient in most cases that trainees be at least familiarized with basic clinical, pathological and epidemiological features of ASF and what they need to do if they suspect one of these diseases. Perhaps the most important thing is to inculcate the understanding

that if confronted by an unusual disease outbreak in pigs, in the field or in the diagnostic laboratory, staff should include ASF among the differential diagnostic possibilities and act accordingly. They should be trained in the steps to be taken to secure a confirmatory diagnosis, including collection and transport of diagnostic specimens and in the immediate disease-control actions to be implemented at a disease-outbreak site. More specialized training will be needed for personnel nominated to specialist diagnostic teams.

There are various training possibilities, including:

- sending key field or laboratory staff to another country to gain firsthand experience of an ASF outbreak or to attend workshops to profit from the experiences of other countries in the process of controlling an outbreak;
- international training opportunities: several countries with access to microbiologically high-security laboratory and animal facilities (e.g. Australia, the USA, UK and South Africa) run training courses demonstrating exotic diseases by experimental infection of susceptible livestock species and laboratory staff can be trained at world or regional reference laboratories and by other international organizations;
- national emergency disease training workshops, which should be the mainstay of training, targeted at government field and laboratory veterinary officers, public health and quarantine veterinarians - including those stationed at abattoirs, markets, border posts, airports and seaports - veterinary practitioners and industry veterinarians; the workshops should include representatives from neighbouring countries and cascade to farmer level by means of workshops organized by those who have been trained;
- field diagnostic manuals, useful if they are simple, practical, graphic and available for quick reference at the site of a disease outbreak.

FARMER AWARENESS/EDUCATION PROGRAMMES

These programmes are critical but sometimes neglected aspects of preparedness planning for emergency diseases. They foster ownership and support for emergency disease control/eradication campaigns by livestock farmers and other stakeholders, engendering a bottom-up approach to planning and implementation of disease-control programmes that complements the top-down approach usually adopted by governments. Communication strategies should aim to make stakeholders aware of the nature and potential consequences of ASF and other important livestock diseases and the benefits of prevention and eradication. They should always have an element of rallying the community to the common cause of preventing or fighting a disease epidemic, ideally resulting in the formation of sanitary defence groups and other farmer organizations. One of the important messages to get across is that it is essential to notify and seek help from government animal health officials as soon as an unusual disease outbreak is seen in pigs. Information about how to do so should be available. Publicity campaigns should be directed towards farmers, local authorities and livestock traders.

SPECIALIST DIAGNOSTIC TEAM

It is recommended that a specialist ASF diagnostic team be nominated that can be mobilized when a suspect outbreak in pigs is reported in the field. These arrangements should be made well in advance of any emergency and the personnel should be available and equipped to travel to a disease outbreak site at short notice. Equipment should include everything needed for preliminary investigation of a disease and for collection and transportation of diagnostic specimens. The composition of the diagnostic team will vary according to circumstances but may include:

- a veterinary pathologist from the central or regional veterinary diagnostic laboratory;
- a specialist epidemiologist, preferably with firsthand experience or training in ASF;
- a veterinarian with extensive experience of endemic diseases in pigs;
- any specialist required for particular examinations.

The team would travel to a disease-outbreak site with local veterinary staff as directed by the CVO and would:

- make clinical examinations;
- collect histories;

- make preliminary epidemiological investigations, particularly in respect to:
 - tracebacks - have any new animals joined the infected herds in recent weeks and where did they come from?
 - traceforwards - have any animals left the infected herds in recent weeks and where did they go to?
- perform autopsies on animals killed in an advanced stage of the disease or on animals recently dead;
- collect diagnostic specimens appropriate to the endemic and exotic diseases included in the differential diagnosis and transport these to the laboratory.

The team should have the authority to take any immediate disease-control actions at the outbreak site. It should report its assessment immediately to the state, provincial or regional veterinary officer and the CVO, specifying steps taken to secure a confirmatory diagnosis and giving advice on further disease-control strategies, including declaration of infected and surveillance zones.

LABORATORY DIAGNOSTIC CAPABILITIES

Rapid and certain diagnosis of diseases can only be assured in fully equipped laboratories with a range of standard diagnostic reagents, experienced staff and a sufficient throughput of diagnostic specimens to maintain expertise. Development of diagnostic expertise for exotic disease tests requiring handling of the live agent should only be attempted in microbiologically secure laboratories.

It is consequently impractical and excessively costly for most countries to maintain a national veterinary diagnostic laboratory with full capability for confirmatory diagnosis of all transboundary and other emergency diseases, many of which will be exotic. It is to be expected, however, that countries with significant livestock populations should have a veterinary diagnostic laboratory equipped and competent to undertake standard techniques in pathology, virology, bacteriology and serology to the level where preliminary identification of aetiological agents for emergency livestock diseases could be attempted. If ASF is deemed to be a high-threat disease, consideration should be given to developing capabilities for some primary key diagnostic tests, such as fluorescent antibody tests.

Containers for transporting specimens should be kept at central, state or provincial veterinary laboratories and should be made available for field veterinary officers and specialist diagnostic teams. The containers should ideally consist of leakproof primary vessels such as glass universal bottles with a metal screw cap and rubber washer or good-quality plastic screwtop jars. They are packed into leakproof secondary containers such as steel paint tins or styrofoam cold boxes with absorbent material and an icepack. This is not necessary if chilling is not an initial option and the samples have been collected into formalin or glycerosaline. The containers are finally placed in robust outer containers with clear labels. Specimen advice notes should also be provided.

INTERNATIONAL REFERENCE LABORATORIES AND COLLABORATING CENTRES

There is a worldwide network of OIE reference laboratories and collaborating centres for ASF, which provide advice and assistance. Their names, contact details, subjects and geographical areas of responsibility are given in Annex 1.

As part of their ASF contingency planning, countries should establish contact with appropriate reference laboratories and collaborating centres and determine the nature and range of diagnostic specimens or isolated agents that should be sent for confirmatory diagnosis or further characterization. It is important to obtain information about transport media that may have to be added, methods of packaging, refrigeration, labelling and any necessary customs or IATA declarations. This information should be documented in 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 geographical locations and 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. Samples must be transported in containers meeting IATA standards.

Full use of reference laboratories and collaborating centres should be made for help with such things as training opportunities, provision of specialized advice in planning and standardized diagnostic reagents.

EARLY REACTION CONTINGENCY PLANNING FOR AN ASF EMERGENCY

INTRODUCTION

This manual mainly addresses the situation where ASF invades a country or zone formerly considered free from ASF. Should such an emergency occur, all initiatives would be directed towards 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 endemic status.

In certain countries where ASF is already endemic, notably in eastern and southern Africa, eradication of the disease is not a viable option. This is because the virus is entrenched in warthog and possibly other wild suid populations and a sylvatic cycle occurs between warthogs and *Ornithodoros* ticks. This does not mean, however, that nothing can be done in these areas. In commercial piggeries, ASF is easily prevented by control actions preventing contact between warthogs, *Ornithodoros* ticks and domestic pigs. Commercial pig farms in endemic areas may be protected from ASF by double pigproof perimeter fencing, a solid wall or single pig-proof fencing if the pigs are permanently housed in solid structures and are unable to approach the fence. Sanitary precautions should be in place, such as limited access for people and vehicles, disinfectant footbaths and measures normally taken to protect the health of intensively farmed animals. Where practicable, efforts should be made to minimize the number of free-roaming or poorly controlled domestic pigs that may have access to infected pigs and material and that could act as a reservoir of infection. In future it may be possible to develop ASF-resistant breeds of pigs for use in endemic areas.

Even in countries where ASF is endemic, it is possible to develop ASF-free zones through strict pig movement and quarantine controls and by enhancing the biosecurity of pig-production units. Active surveillance involving owner observation and farm and abattoir veterinary inspection is a prerequisite for credibility.

EPIDEMIOLOGICAL FEATURES INFLUENCING ASF ERADICATION STRATEGIES

There are several epidemiological and other factors which influence eradication strategies for ASF, some favourable but most unfavourable. They include the facts that:

- ASF virus is resistant to inactivation and may remain viable for long periods in fomites, infected pig tissues, meat and processed pig products;
- no domestic livestock species other than pigs is susceptible to ASF;
- humans are not susceptible;
- many wild suid species and feral pigs are susceptible to ASF but may not develop overt disease;
- *Ornithodoros* ticks transmit ASF virus;
- ASF is a highly contagious disease in domestic pigs;
- ASF is usually clinically apparent in pigs but may be confused with other diseases, notably CSF; low-virulent strains of the virus may be more difficult to detect;
- pigs that survive ASF infection may become carriers, although their role in transmitting the virus after about a month is uncertain; their tissues nevertheless remain infective for a period after active shedding has ceased;
- there is no vaccine available for ASF.

The above factors make ASF one of the more difficult TADs to eradicate. Nevertheless there are numerous examples from Europe, Africa and South America that demonstrate that ASF can be eradicated from countries by concerted, well organized campaigns.

STRATEGIES FOR ASF ERADICATION

In the absence of vaccines, the only available option for ASF eradication is stamping out by slaughter and disposal of all infected and potentially infected pigs. This is a proven method which has succeeded in eradicating ASF and other serious transboundary diseases such as foot-and-mouth disease and rinderpest.

The main elements of a stamping-out policy for ASF are:

- zoning of the country into infected zones, surveillance zones and free zones;
- quarantine procedures to contain the disease, including pig-movement controls and prohibitions on the sale of potentially infected pig products;
- enhanced epidemiological surveillance for ASF;
- immediate slaughter of infected and potentially infected in-contact pigs, with prompt and fair compensation to owners;
- safe burial or burning of carcasses and other infected materials;
- cleansing and disinfection of infected premises;
- keeping infected premises/villages without pigs for a safe period.

The above procedures must be applied for a period long enough to eradicate the disease and should be accompanied by extensive public-awareness campaigns.

Stamping out tends to be a resource-intensive method of disease eradication in the short term. It generally proves to be the most cost-effective method, however, and allows countries to declare freedom from disease in the shortest time. The latter may be important for international trade purposes.

ZONING

Zoning is the proclamation of geographical areas in which specific disease-control actions are to be carried out. The zones are concentric areas 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 ASF into a country. The size and shape of the zones may be determined by administrative or geographical boundaries or by epidemiological or resource considerations. However, because ASF is not spread by aerosol but by movement of infected material, it is important to bear in mind that transmission can occur overnight over hundreds or thousands of kilometres by road or air. During an epizootic, it would be short-sighted to depend on the declaration of infected zones to contain the disease unless there is a high level of confidence that the movement of pigs or dangerous materials such as pig meat from infected to free zones can be prevented by geographical barriers or control measures. Experience has demonstrated that establishment of a cordon sanitaire is far from simple in many countries and that such measures are easily evaded. It is certain that poorly organized pig farms distant from the zone of infection may be at greater risk than well managed commercial farms within the infected zone.

Zoning is now recognized as an important principle in the definition by OIE of national animal health status.

FIGURE 4



Zoning

It is important to have simple logistics, for example an office and desk, maps and writing materials, ready to hand to carry out emergency planning such as zoning.

Infected zones

An infected zone encompasses the area immediately surrounding one or more infected farms, premises or villages. Its size and shape are influenced by topographical features, physical barriers, administrative borders and epidemiological considerations. OIE recommends that it should have a radius of at least 10 km around disease foci in areas with intense livestock raising and 50 km in areas of extensive livestock raising. Intensive livestock raising would mean areas where pigs are securely confined in premises or farms; extensive livestock raising areas are those where some pigs are allowed to roam or are poorly controlled.

When dealing with a disease like ASF where there is no aerosol transmission, the use of radii to define infected zones may not be appropriate in practice. In rural areas in a number of countries, a proportion of the pigs in any area will be poorly controlled, so declaration of 50 km zones where expensive and drastic measures will be applied is unnecessary and impractical. In order to determine infected zones, the extent of the focus of infection must be determined and well managed farms that have escaped infection must not be regarded as infected. On the other hand, strict vigilance must be maintained over a much wider area, depending upon known patterns of pig movements determined by marketing and other considerations.

In the initial stages of an outbreak, when its extent is not well known, it would be wise to declare larger infected zones and then progressively reduce them as active disease surveillance reveals the true extent of the outbreak.

Surveillance (control) zones

These zones are much larger and surround one or more infected zones. They may cover a province or administrative region and in many cases cover a whole country.

ASF-free zones

These encompass the rest of the country. Because of the potential of ASF for wide dissemination, however, it is recommended that all parts of a country experiencing a first outbreak are placed under a high level of surveillance. The emphasis in ASF-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. Information should be provided in these zones on the same basis as zones in which the outbreak occurs. This information should be extended as quickly and securely as possible to neighbouring countries.

Infected premises and dangerous-contact premises

In this context, an infected premises (IP) means an epidemiological entity where pigs have become infected. It may be a single farm or household or an entire village or settlement. It may be a livestock market or abattoir. A dangerous-contact premises (DCP) is one for which there are epidemiological grounds to suspect that it has become infected, even though the disease is not yet clinically apparent. This might be through close proximity or as a result of epidemiological tracing.

ACTIONS TO BE TAKEN IN INFECTED ZONES

There are two objectives in the infected zone: to prevent further spread of infection through quarantine and livestock movement controls and to remove sources of infection as quickly as possible through slaughter of potentially infected pigs, safe disposal of carcasses and decontamination.

The balance of actions towards these objectives depends on circumstances. An important decision must be made between two options. If pigs in the infected zone are not well controlled and there is a risk of further rapid spread of the disease or transfer to wild pigs, or if resources for surveillance and imposition of quarantine and movement controls are inadequate, it may be expedient to slaughter all pigs in the infected zone or in specific areas of the zone. On the other hand, if pigs are securely contained on farms and resources for surveillance and imposition of quarantine and movement controls are adequate, the best decision would be to slaughter pigs only on IPs and DCPs.

Disease surveillance and other epidemiological investigations

Intensive active surveillance for ASF must be undertaken, with frequent clinical examination of pig herds by veterinary officers or inspection teams. These officers or teams must of course practise good personal decontamination procedures to avoid carrying infection to the next farm they inspect.

At the same time, traceback and traceforward investigations should be carried out whenever an infected pig herd is found. Tracing back means determining the origin of any new pigs brought on to an IP in the three or four weeks before the first clinical ASF cases, which may have been the source of infection, and inspecting the farms in question. Tracing forward means determining the destination of pigs leaving the IP prior to or after the first clinical cases. Farms that may have become infected by these pigs are then inspected. Traceback and traceforward investigations quickly become complicated if pigs have transited through livestock markets or saleyards.

Quarantine of IPs and DCPs

IPs and DCPs should be immediately quarantined with a ban on the exit of live pigs, pig meat and other potentially contaminated materials, pending further disease-control action. Vehicles and other equipment should be disinfected before leaving.

Movement controls

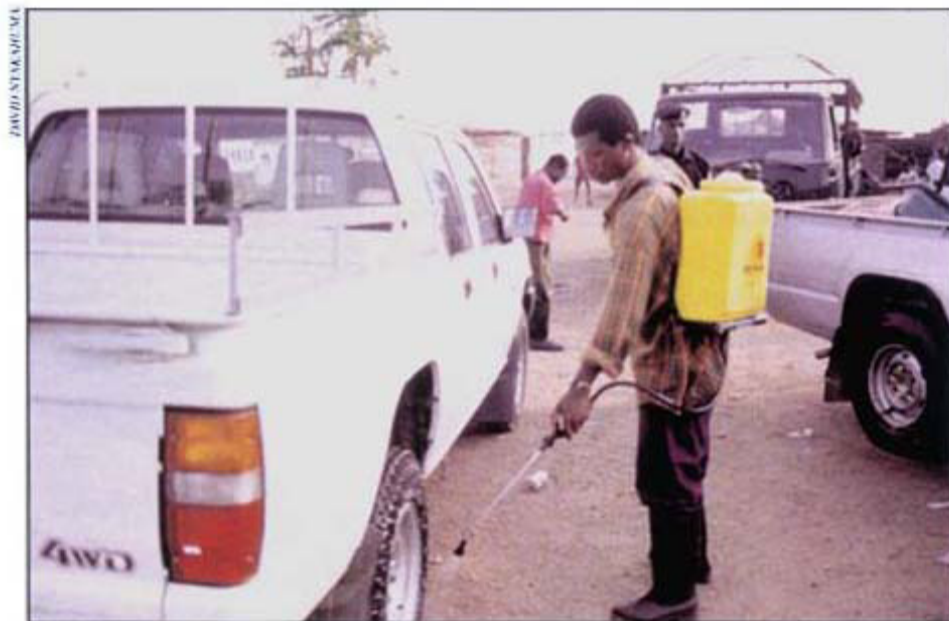
There should be a complete ban on the movement of live pigs, pig meat and pig products inside and out of the infected zone. Great care is required to ensure that neither live pigs nor pig meat

are smuggled out of the infected zone. Because of the high risk that they constitute for spread of infection, pig markets and abattoirs should be closed.

Slaughter of infected and potentially infected pigs

All pigs on IPs and DCPs, or in a larger area if necessary, must be slaughtered immediately, whether they are obviously diseased or not. Owners should be asked to collect and confine their pigs the day before the slaughter team arrives. The animals should be slaughtered by methods that take account of animal welfare and the safety of operatives. Rifles or captive-bolt guns are most commonly used for pigs. The latter should not be used in confined areas where there is danger of ricochets. Lethal injections (e.g. barbiturates) may be used for unweaned pigs or pigs of any age if practical. If a captive-bolt weapon is used, operatives should take into account the fact that pigs may be stunned and not killed and use appropriate measures to ensure that animals are dead before burial or burning. Rifles should only be used by competent and experienced marksmen, to avoid compromising the safety of people and animals other than pigs.

FIGURE 5



Disinfection

Thorough disinfection of vehicles is essential during an emergency disease outbreak to prevent the disease from spreading to other premises.

FIGURE 6



Humane killing

A stunner being used for humane killing of pigs during an ASF outbreak.

FIGURE 7



Deep burial

Deep burial is the recommended method of carcass disposal to ensure elimination of the virus from the environment.

FIGURE 8



Burning

Burning requires considerable skill to achieve effective results. In most cases the carcasses are not incinerated but merely roasted.

If pigs are poorly confined or are allowed to scavenge in the surrounding countryside, it may be necessary to send out teams of marksmen to locate and shoot them.

Reference should be made to the *FAO Manual on procedures for disease eradication by stamping out* for more information on slaughter procedures.

Safe disposal of carcasses

This means disposal of the carcasses of animals that have been slaughtered or died naturally of the disease. It must be done in such a way that the carcasses no longer constitute a risk for further spread of the pathogen to other susceptible animals by direct or indirect means, for example by carrion eaters, scavengers or through contamination of food or water. This is usually done by deep burial, depending on the nature of the terrain, level of watertables and availability of earth-moving equipment, or by burning, depending on availability of fuels and the danger of starting grass or bush fires. If in situ disposal is not practical, it may be possible to transport carcasses in sealed vehicles to a disposal point. This should be done within the infected zone. It is not ideal, especially in countries where sealed vehicles are not available and where vehicles in general are prone to breakdown. If it must be done, provision should be made for an escort vehicle to disinfect any leakages and initiate salvage operations should the vehicle transporting the pigs develop technical problems or be held up.

Under some circumstances it may be desirable to mount a guard at the disposal site for the first few days.

Reference should be made to the *FAO Manual on procedures for disease eradication by*

stamping out for more information on disposal procedures.

Decontamination

This involves thorough cleaning and disinfection of the environs of IPs, with particular attention to places where animals have congregated - animal houses, sheds, pens, yards and water-troughs.

FIGURE 9



Disinfection

Disinfection is vital during the slaughter process to reduce the risk of contaminating the environment with the ASF virus or other pathogens.

Potentially contaminated materials such as manure, bedding, straw and feedstuffs should be removed and disposed of in the same way as carcasses. It may be simpler to burn poorly constructed animal housing where there is a danger of *Ornithodoros* ticks. If ticks are absent, spraying with a disinfectant effective against ASF should be sufficient, as the virus does not remain viable for long outside a protein environment.

Appropriate disinfectants for ASF include 2 percent sodium hydroxide, detergents and phenol substitutes, sodium or calcium hypochlorite (2–3 percent available chlorine) and iodine compounds.

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

Destocking period

After slaughter, disposal and decontamination procedures must be completed and the premises left destocked for a period determined by the estimated survival time of the pathogen. As a general rule, this would be shorter in hot climates than in cold or temperate climates. A minimum of 40 days is recommended by OIE. A shorter period would probably be safe in tropical areas, because it has been shown that sties in such areas are safe for repopulation, even without cleaning or disinfection, after five days. In practice it is unlikely that definitive stamping out of a focus would be completed in less than 40 days.

ACTIONS TO BE TAKEN IN SURVEILLANCE ZONES

The following disease-control actions should be undertaken in surveillance zones.

- There should be enhanced active disease surveillance for ASF. Pigs in the zone should be inspected at weekly intervals and their owners questioned about disease occurrences, pig movements etc. Sick pigs should be thoroughly investigated and diagnostic samples sent to the laboratory. Surveillance is easier if some of the tasks can be delegated to informed and trained pig farmers.
- Movements of pigs, pig meat and pig products from infected zones should be banned. Movements from surveillance to free zones may be allowed but only after health inspection and the issue of a permit.
- Abattoirs and pig meat processing plants may be allowed to operate but must be subjected to strictly enforced zoo-sanitary codes of practice.
- Sales of live pigs and pig meat may be allowed to continue unless they constitute a threat of further spread of the disease. They should be subjected to surveillance and rigidly enforced codes of practice.

ACTIONS TO BE TAKEN IN DISEASE-FREE ZONES

The emphasis in ASF-free zones is on preventing entry of the disease and accumulating internationally acceptable evidence that the zones are indeed ASF-free.

Entry of pigs or pig products from infected zones should be banned or only allowed subject to official permits from surveillance zones. Well managed, accredited pig farms in infected zones should be treated as if they were surveillance zones.

REPOPULATION

At the end of the agreed destocking period, pigs may be reintroduced to previously infected farms or villages. This should only be done, however, if there is reasonable certainty that these farms/villages will not be reinfected. Restocking to full capacity should only take place after sentinel pigs have been introduced at approximately 10 percent of the normal stocking rate on each previously infected farm. These pigs must be observed closely for six weeks to ensure they stay free of ASF before full repopulation. After repopulation, intense active surveillance for the disease should be maintained in the area at least until international declarations of freedom can be made.

FIGURE 10



Sentinel animals

Sentinel animals require routine observation and examination to ensure that they are free of ASF during the stand-down phase.

It is essential that pigs used for repopulation come from known ASF-free zones or countries. If pigs are imported from other countries, the disease status of those countries with respect to other important diseases of pigs must be known. It would be disastrous to replace ASF with another disease that might take many years and great expense to eradicate. The opportunity could be taken for upgrading pig genetic stocks in the area as part of the repopulation programme, provided the pigs are brought in from reliable sources such as local commercial farms that have remained uninfected.

SOME FACTORS CRUCIAL TO THE SUCCESS OF AN ASF ERADICATION CAMPAIGN

Public awareness and education

Public-awareness and education campaigns should be important integral elements of the disease eradication campaigns. They should be mainly targeted at rural and peri-urban communities affected by the disease and ASF-control actions. Radio programmes and village meetings are the most appropriate means of getting the message across to these people. Meetings are particularly suitable, as there will be community involvement and the opportunity to ask questions and disseminate material such as pamphlets and posters that will reinforce the information.

FIGURE 11



Compensation

Scavenging pigs are hard to capture during stamping out, yet they are usually the major target of the exercise. These pigs usually hide in forests and thick bushes when chased and nobody claims ownership in such cases. An effective method of culling them in Togo and Ghana was to mobilize village vigilante groups to hunt them. The carcasses were collected, disinfected if necessary and disposed of by deep burial.

The campaign 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 ASF. It should emphasize that ASF control primarily benefits pig producers and not the government.

Compensation

It is essential that farmers and others who have had their pigs slaughtered, pig meat products confiscated or property destroyed as part of an ASF eradication campaign should be fairly compensated with the current market value of the animals and goods. 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 categories of pigs, pig meat and other materials. At least the market value of the pigs should be paid. Under some circumstances, replacement of stock may be offered in lieu of monetary compensation. Failure to pay adequate and timely compensation will seriously compromise ASF eradication campaigns by causing resentment and lack of cooperation. Such a failure would act as a spur to illegal smuggling and clandestine sale of pigs out of infected areas to avoid losses.

Social support and rehabilitation

An ASF-eradication campaign is likely to produce hardships for affected farmers and communities during the epizootic and the recovery phase. Consideration should therefore be given to government support to affected groups. There may be food shortages, particularly in infected zones, and it may be desirable to provide supplementation either in the form of pig meat or other types of animal protein from disease-free zones. Affected farming communities may need rehabilitation support to help them get back to normal at the end of the campaign. Assistance should be given to farms that have escaped infection but are unable to sell pigs because of bans on movement or closure of abattoirs and that have large numbers of pigs growing and eating on their farms. Where controlled slaughter is not a possibility, some assistance in the form of subsidized feed should be considered. It must be recognized that farmers who have avoided

infection in the face of an epizootic are a national resource and should be rewarded rather than penalized.

VERIFICATION OF ASF ERADICATION AND NATIONAL OR ZONAL FREEDOM FROM THE DISEASE

International requirements

The OIE *International animal health code* specifies that a country may be considered free from ASF when it has been shown that ASF has not been present for at least three years. This period is reduced to 12 months, however, for previously infected countries in which a stamping-out policy is practised and in which it has been demonstrated that the disease is absent from domestic and wild pig populations.

A zone of a country may be considered free from ASF when the disease is notifiable in the whole country and when no clinical, serological or epidemiological evidence of ASF has been found in domestic or wild pigs in the zone during the past three years. This period will be 12 months for a previously infected zone in which a stamping-out policy is practised and in which it can be demonstrated that the disease is absent from domestic or wild pig populations.

The free zone must be clearly delineated. Animal-health regulations preventing movement of domestic or wild pigs into the free zone from an infected country or zone must be published and rigorously implemented. Regular inspection and supervision of pig movements should be made in the free zone to ensure freedom from ASF.

Proof of freedom

An internationally accepted protocol has not yet been established for verification and proof of freedom from ASF, unlike rinderpest, where there is an accepted OIE pathway for demonstration of disease freedom. Evidence that could be provided to gain international acceptance of regained national ASF freedom might include documentation to show that:

- the country has an effective national veterinary service able to prevent re-entry of ASF, detect outbreaks and take prompt action against them;
- there is an effective disease-surveillance system in place, with regular searches for ASF by field, laboratory and abattoir veterinary services;
- suspected cases of ASF are fully investigated, with documentation including the final diagnosis of the disease incident;
- comprehensive random, stratified serological surveys¹ have been carried out with negative results.

Wild pig populations must have been examined for evidence of ASF infection. This could be done by shooting some animals in representative areas and examining tissues for ASF antigen and sera for antibodies. There is in most countries a hunting season, during which arrangements can be made to obtain carcasses of warthogs and other wild pigs shot for trophy purposes and meat. Serological evidence is sufficient proof of past infection, so where funds are available, bleeding tranquillized wild pigs would suffice.

¹ FAO. 1999. *Manual on livestock disease surveillance and information systems. Animal health manual No. 8.*

ORGANIZATIONAL ARRANGEMENTS DURING AN ASF EMERGENCY CAMPAIGN

RESPONSIBILITIES AND COMMAND STRUCTURES

The national CVO, or equivalent such as a director of veterinary services, should have overall technical responsibility for preparedness for and management of ASF emergencies. The appropriate government minister will, of course, be ultimately responsible.

In recent years, the national veterinary services of many countries have been restructured and rationalized. This has included regionalization and devolution of veterinary services, privatization of veterinary services 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. They are often unsuitable, however, for managing a major animal-health emergency such as an ASF eradication campaign. In such an emergency, there is a need to make rapid decisions based on analysis of the best information available from all sources. It must be possible to convert those decisions into clear orders that can be conveyed to those charged with the responsibility for carrying them out. There must be means of knowing that orders have been carried out and with what results. In short, there must be efficient mechanisms in place for transmission of information and instructions from the national veterinary services headquarters to the front line 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, a country's veterinary services must be organized as a command structure or line management system at least for the duration of the emergency response to an ASF outbreak.

There should be forward planning so that appropriate structures and lines of responsibility can be rapidly and efficiently put in place when an ASF emergency arises. This may include organizing one or more of the following well in advance of any emergency:

- agreement that animal-health emergencies will be handled at national level and that the CVO will assume overall responsibility for responding to the emergency and will be directly answerable to the minister;
- a mechanism for cooperation between ministries, e.g. police, army, education, media and health, which usually necessitates establishment of an inter-ministerial committee; it is advisable that such a committee should exist permanently, avoiding the bureaucracy of establishing it in an emergency;
- 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, with arrangements to ensure that regional field and laboratory veterinary services are fully involved in emergency preparedness planning and training activities;
- collaboration with national veterinary headquarters to provide early warning of emergencies, including emergency disease reporting to national headquarters;
- arrangements for essential government veterinary services, including the central veterinary laboratory, to come within the command structure of the CVO for the emergency response;
- contracts for private-sector veterinary organizations, universities and other academic institutions and research institutes to provide essential services during an animal-health emergency;
- negotiation with the national veterinary association of terms and conditions for hiring private-sector veterinarians as temporary government veterinary officers if needed.

In many countries, the private sector is small or non-existent and it may be necessary to rely on non-veterinary assistance for disease control. There should therefore be a mechanism to mobilize the resources available in related sectors such as agricultural extension, giving appropriate training. In controlling animal diseases, it is vital to identify all potential participants and ensure that they are prepared to act immediately in the event of an epizootic.

CONSULTATIVE COMMITTEE ON EMERGENCY ANIMAL DISEASES (CCEAD)

Countries may find it very useful to establish a CCEAD that can be convened as soon as there is an ASF emergency and that can meet regularly during the emergency response. It would be an essentially technical committee, whose role would be to review epidemiological and other disease-control information, recommend activation of contingency plans, oversee the campaign and advise the CVO and the minister on future planning of the campaign.

A suggested composition of the CCEAD might be:

- the 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 regional veterinary laboratories covering the outbreak areas;
- representatives of farmer groups or organizations;
- representatives of other key groups such as a national veterinary association or universities;
- technical experts as required, with observer status.

If the command structure cannot be implemented, it is essential that a CCEAD be established, so that there can be a consensus approach to the conduct of the ASF campaign.

NATIONAL ANIMAL DISEASE CONTROL CENTRE

Countries should establish permanent national animal disease control centres. In the event of an outbreak of ASF or other emergency animal disease, the centre should be responsible to the CVO for coordinating national emergency disease-control measures. The centre should be in the national veterinary services headquarters. The national epidemiology unit should be attached to the centre or should work in close collaboration with it. The CVO may delegate day-to-day responsibilities for implementing policy to the head of the centre, who would normally be a senior government veterinarian. The responsibilities of the national animal disease control centre in the emergency response would include:

- implementing disease-control policies decided by the CVO and the CCEAD;
- directing and monitoring operations of local animal disease control centres;
- maintenance of up-to-date lists of personnel and other resources, with details of where further resources may be obtained;
- deployment of staff and resources to local centres;
- ordering and delivering supplies, including vaccines for diseases other than ASF;
- monitoring progress of the campaign and providing technical advice to the CVO;
- advising the CVO on definition and proclamation of disease-control zones;
- maintenance of up-to-date lists and contact details of risk enterprises;
- liaison with groups involved in the emergency response, including those that may be activated as part of the national disaster plan;
- preparation of international disease reports and cases for recognition of zonal or national freedom from the disease;
- management of farmer awareness and publicity programmes, including press releases;
- general and financial administration and record-keeping.

The national animal disease control centre should be fully equipped with 1:50 000 maps of the country and communication equipment for liaison with regional veterinary services or local animal

disease control centres and veterinary laboratories, including telephone, radio, e-mail and fax. The centre should be linked with the emergency disease information system.

LOCAL ANIMAL DISEASE CONTROL CENTRES

During the ASF emergency, district offices of the veterinary services closest to the infected foci or district offices of the agricultural extension services act as local animal disease control centres. Teams should be able to travel in one day to and from any site for surveillance or other disease-control activities. Locations for temporary local disease control centres, such as local government offices, should be negotiated for in advance.

Regional and district veterinary officers should be in charge of disease-control operations in their areas, with the right to enter farms, collect samples and take measures to prevent movement of pigs and pig products within and out of the areas under their control. They should be provided with materials for collection and transmission of samples, a refrigerator for short-term storage, protective clothing, stores of disinfectant, a vehicle and fuel and means to contact the CVO. Political structures should enable them to enlist the cooperation of other services, such as police, agricultural extension officers and the media to prevent dissemination of disease. They should be provided with materials to carry out a public information campaign and intensive farmer training and information. Above all, they should be at all times in possession of accurate information about the status of the disease and slaughter and compensation levels.

SUPPORT PLANS

Support plans provide the backing to enable implementation of the ASF or other emergency disease contingency action plans.

FINANCIAL PLAN

Experience has shown that delay in obtaining finances is a major constraint to rapid response to emergency disease outbreaks. Immediate application of even modest funds can save major expenditure later. Forward financial planning is therefore an essential component of preparedness.

Financial plans need to be developed to provide immediate provision of contingency funds to respond to disease emergencies. These are for expenditure required over and above normal operating costs for government veterinary services. Plans should be approved by government departments, including economic planning authorities and the department of finance.

The funds may cover the cost of the whole eradication campaign. They usually cover the initial phases of the campaign, pending a review of the outbreak and the control programme and funds required to finalize eradication.

The conditions under which funds may be released should be specified in advance. They would normally be provided to the CVO when:

- ASF or another emergency disease has been diagnosed or suspected;
- the outbreak can be controlled or eradicated;
- there are approved disease-control plans in place.

The funds may be held as special funds sequestered for the purpose or as drawing rights against a government account to an agreed amount.

In some countries, it may be desirable for funds to be provided by the government and private sector for emergency programmes against ASF and other diseases, as agreed after reviewing the nature and proportion of public and private benefits derived from elimination of the disease. A funding formula may be agreed upon, covering payment by each sector of a fixed percentage of the total cost of the campaign or whereby each sector pays for specific components. If the private sector is to contribute, it must be determined who benefits and therefore who should share the cost. This may include processing industries, traders and farmer organizations. It must be determined how private-sector funds will be raised. This could be done by livestock industry levies, perhaps on livestock transactions or slaughterings, held in secure funds or industry insurance. Voluntary individual insurance policies are satisfactory for insuring against losses from a disease or disease-control actions but are unsatisfactory for raising campaign funds.

It may be that funding of the whole emergency disease eradication campaign is beyond national resources. In this case, forward planning should be carried out to identify potential international donors, including emergency support from FAO or other international agencies. Procedures for applying for funding and requirements for submitting an application should be determined in advance.

The financial plan should include provisions for compensation to owners for livestock or property destroyed as part of the disease eradication campaign. Inadequate compensation is inherently unfair and counterproductive to the campaign, fostering resentment and lack of cooperation. It also encourages farmers to hide the presence of the disease. Compensation should be based on a fair market value of the animals at the time of slaughter, assuming values for healthy animals. The same principle should be applied to products and property. Valuation should be done by

independent, professional valuers. If individual valuations are not practical, generic valuations for different classes of livestock may be acceptable. Compensation for consequential rather than direct losses are difficult to administer and are inappropriate. If replacement of stock after a period is considered a better alternative than cash compensation, it should be confirmed in consultation with pig owners, as some may be discouraged from resuming pig farming.

RESOURCE PLANS

The first step in preparing a resource plan is to make a resource inventory. This is a list of resources needed to respond to a moderate-sized outbreak of ASF or another high priority emergency disease, including personnel, equipment and other resources. The following resource lists should be regarded as indicative rather than exhaustive:

National animal disease control centre

- senior disease control veterinarians and epidemiologists;
- financial and administrative officers;
- staff for recording and processing epidemiological and other information;
- maps of scale 1:50 000 and 1:10 000;
- computers;
- communication equipment to local headquarters, e.g. telephone, fax and e-mail.

Local animal disease control centres

- senior disease control veterinarians and epidemiologists;
- technical support and administrative officers;
- offices;
- office equipment;
- maps;
- telephone and fax;
- proformas for disease control operations.

Under some circumstances, computers with e-mail may be available.

Diagnostic laboratories

- trained laboratory staff;
- standard laboratory equipment;
- specialized equipment for key emergency diseases;
- diagnostic reagents for antigen (FA) and ELISA.

Diagnostic/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;
- animal-restraint equipment.

Slaughter, burial and disinfection

- supervising veterinarian and other personnel;
- transport;
- humane killers, ammunition or other approved means of killing, such as carbon monoxide for poultry;
- protective clothing;
- animal-restraint equipment;
- front-end loaders and earthmoving equipment;
- approved disinfectants, soaps and detergents;
- shovels and scrapers;
- high-pressure spraying equipment;

- fuel for incineration, generally diesel mixed with a small amount of petrol and old tyres to expedite burning by encouraging air circulation and maintaining high temperatures.

Quarantine and livestock movement controls

- enforcement teams;
- transport;
- road blocks;
- signs and posters.

A list of existing resources should be prepared, including specifications, quantities and locations. A register of specialist staff should be maintained, with qualifications and experience with ASF. Resource lists and staff registers should be maintained at the national disease control centre and regional offices.

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

There are various options for obtaining the necessary extra resources:

- a list of places where essential equipment and stores may be purchased, hired or borrowed;
- a central store of hard-to-obtain items, such as disinfectants, and items that take time to prepare, such as proformas;
- arrangements for supply of personnel and equipment from other government agencies, e.g. earthmoving equipment from the department of works and transport and communications equipment from defence forces;
- arrangements made through veterinary associations for temporary employment or secondment of veterinary practitioners in an emergency.

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

It should be noted that to maintain adequate diagnostic capacity and ensure competence, laboratories should routinely perform basic tests on specimens of known and unknown status and send test samples to reference laboratories from time to time to cross-check even negative results.

The resource plan and inventory lists need to be regularly updated.

LEGISLATION

Acts of parliament or government regulations providing the legislative framework and powers to carry out disease control actions need to be put in place as part of preparedness planning. This may include legislation to:

- make ASF and other animal diseases compulsorily notifiable;
- allow entry of officials or other designated persons on to farms or other livestock enterprises for disease-surveillance purposes, including collection of diagnostic specimens, and to implement disease control;
- authorize proclamation of infected areas and disease-control zones;
- authorize the quarantining of farms or other livestock enterprises;
- authorize bans on movements of livestock, livestock products or potentially contaminated materials and issue permits for movement under specified animal health conditions;
- authorize compulsory destruction and safe disposal of infected or potentially infected animals and contaminated or potentially contaminated products and materials, subject to fair compensation;
- authorize other disease-control actions;
- provide for compensation to owners of livestock and property destroyed as part of disease-control programmes and define standards for such compensation;

- allow codes of practice to be mandated for risk enterprises and livestock markets, abattoirs and knackeries and authorize disease-control actions for them;
- authorize compulsory identification of animals where appropriate.

For countries which operate under a federal system of government, there should be harmonized, consistent legislation for animal disease emergencies throughout the country. The same should apply between countries in regions where there is unrestricted exchange of livestock and animal products under free-trade pacts, such as the European Union, the Mercosur countries in South America, the Economic Community of West African States (ECOWAS) and the Southern African Development Community (SADC).

ACTION PLAN

The action plan is a set of instructions covering controls to be implemented during an ASF emergency, from first suspicion of the disease to final eradication. It details actions to be taken from the first report of suspected ASF.

Since the veterinary structure differs from country to country, this chapter provides a general guide to actions to be carried out during each phase of an outbreak of ASF. Each country should develop its own action plan, in which persons responsible for each action should be identified. Lines of communication between pig owners, field and national veterinary services must be identified and made known to all parties. These communication lines underpin the chain of command that will be activated in the event of suspicion of ASF. The success of the action plan depends on each link in the chain of command functioning as specified in the plan.

It is expected that countries will prepare detailed generic operating procedures applying to ASF and 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.

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. The standards that can be attained will vary from country to country, however, 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, an island with a highly developed economy and commercial agricultural sector and a sparse and sophisticated human population.

INVESTIGATION PHASE

The investigation phase exists when a report of probable ASF is received by the veterinary services. It should be a clearly understood legal obligation of any citizen suspecting the presence of ASF or other serious animal disease to report to a member of the veterinary or animal health services either directly or through the chain of communication, for example the village assembly person, agricultural-extension officer or district authority. A suspicious index case or exceptionally high mortality among pigs 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 private veterinary practitioners and ancillary veterinary staff such as community-based animal health workers employed by government or non-governmental organizations.

Once a report of suspected ASF is received, the following actions must be taken:

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

On receiving information that could indicate ASF, the local veterinary authority should carry out an investigation by visiting the location of the index case/s to gather information about clinical and epidemiological features of the case and collect specimens to aid diagnosis. Specimens should be transported on ice, or in 50 percent glycerosaline if refrigeration is not available, to the nearest laboratory as soon as possible. The remaining pigs should be examined. If there are grounds to suspect ASF, 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 to prevent movement of pigs and pig products, pending further investigation.

Depending on the size of the country and veterinary hierarchy, lines of communication from farm level to national veterinary authority may contain few or many links. In essence, faced with the possibility of ASF, the report should reach the DVS as soon as possible. Investigating false alarms may result in inconvenience and unnecessary expenditure but the consequences of missing the index case because somebody with imperfect knowledge of the disease was not sufficiently convinced can result in catastrophe. In countries previously uninfected, it is most unlikely that the index case will be the first to have occurred.

If the investigation shows that the circumstances are not suggestive of ASF or an alternative diagnosis can be made, a false alarm may be declared and operations wound down. 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 suspicion of ASF without fear of being proved wrong. To control important diseases of livestock, it is most important to develop a culture of reporting suspicious events.

ALERT PHASE

If clinical and epidemiological results are highly indicative of ASF, particularly the death of large numbers of pigs of all ages over a short period of time, 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 DVS or CVO should:

- ensure that measures are in place to enforce control at local level, i.e. quarantine of infected premises and prohibition of movement of pigs and pig products;
- activate the national emergency preparedness plan for ASF;
- make arrangements to ensure that funds are available to cover field investigation;
- insure that equipment, materials and transport are available;
- appoint and dispatch the ASF expert team, which should include an epidemiologist, a laboratory diagnostician and a control officer, with technical support;
- alert police, army and other government departments, if necessary by convening a meeting of the interministerial committee where this is a prerequisite for cooperation;
- define zones of control and observation;
- alert provincial and regional CVOs, given the potential of ASF to spread rapidly over long distances.

Directors of veterinary services in neighbouring countries should be alerted, because of the potential for rapid transboundary spread before diagnosis has been confirmed, especially in continental countries with porous borders.

If national and local pig farmers' associations exist, alerting them to the situation as soon as possible will assist in ensuring their support and cooperation should ASF be confirmed and will have a beneficial effect on enforcement of quarantine.

The ASF expert team, in collaboration with local veterinary personnel, should investigate the case *in situ* by:

- conducting detailed clinical and post mortem examinations;
- collecting epidemiological information, including backward and forward tracing to determine possible origin and estimate the likelihood of spread already having occurred;
- collecting specimens, which should include specimens to rule out differential diagnoses.

After a visit to potentially infected premises, the team leader should ensure that proper disinfection procedures are carried out to prevent iatrogenic transmission of the disease.

Specimens should be delivered with minimum delay, chilled or preserved, to a laboratory with the capacity to carry out the diagnosis. In the case of countries without laboratory diagnostic capacity for ASF, they should be sent to a reference laboratory.

If the investigation *in situ* indicates other foci of infection as either the source or recipient of infected material, these foci should be investigated immediately, provided that the diagnostic samples from the index case have been delivered. The same procedure should be followed as for the index case.

OPERATIONAL PHASE

The operational phase is initiated when ASF occurrence has been confirmed and an ASF emergency is declared. Immediate actions required are:

- international reporting of ASF infection;
- obtaining political support for control activities;
- a public-awareness campaign;
- destruction of infected and in-contact pigs, with compensation, and decontamination of premises;
- prevention of movement of pigs and pig products from infected foci;
- institution of national surveillance for ASF.

INTERNATIONAL REPORTING

The declaration of infection should be sent by the DVS to global authorities such as OIE and FAO and regional organizations and officially communicated to neighbouring countries.

Delay in reporting to neighbouring countries can have serious consequences in terms of ASF control and political relations.

OBTAINING POLITICAL SUPPORT

The minister responsible for the veterinary department should be made aware the importance of at least the List A diseases before any outbreak occurs. Immediately upon confirmation of ASF, an interview should be arranged to brief the minister about the current situation, the salient facts about the disease, legislation affecting disease control and the budget for disease-control measures. This should be accompanied by a realistic estimate of the cost to the country should control fail, which should be prepared in advance and regularly updated to accommodate inflation and changing circumstances such as growth and modernization of the pig industry. Permission to mobilize the emergency fund for ASF control should be obtained.

PUBLIC-AWARENESS CAMPAIGN

An effective organized public-awareness campaign is probably the most important aid in control of ASF. The campaign must be an intrinsic part of the action plan. Countries will have characteristics that determine the type of campaign that will succeed best but certain basic rules apply to all countries.

- Make use of multiple media. The best penetration into remote communities is achieved by radio programmes presented in local languages, because people may be illiterate or only receive newspapers days after publication, and may lack television. Announcements via television and newspapers are needed to reach the more sophisticated people.
- Widespread dissemination of eye-catching posters and pamphlets reinforces the campaign.
- Avoid sensationalism and untrue statements, for example that ASF causes human disease. Concentrate on real disadvantages, such as an increase in the price of feeding the family.
- Public meetings are an effective way of informing people about the disease, enabling them to ask questions and offer information.
- Draw on the experience of other countries to underline the severe consequences of ASF.

- Keep the public informed about the progress of the campaign by means of regular updates.

FIGURE 12



Public-awareness campaign

An effectively organized public-awareness campaign is required at each phase to ensure public cooperation.

If there are national and local pig farmers' associations, it is politic to ensure that they are informed of the situation ahead of the general public. Their cooperation is central to the success of control measures and like neighbouring countries they will be alienated by receiving the news at second hand.

SLAUGHTER, DESTRUCTION AND DECONTAMINATION

Destruction of infected and in-contact pigs should be carried out by a team equipped to destroy pigs in a humane manner acceptable to owners, dispose of carcasses in such a way as to prevent retrieval and consumption of meat and decontaminate premises and themselves. Disposal of carcasses and infected material such as bedding and residual feed by deep burial and incineration is recommended. This should take place as close as possible to the infected premises, as transport of potentially infected carcasses to distant sites is not recommended: dangers include spillage of infected fluids, breakdown of vehicles and theft. Informed pig farmers do not want vehicles carrying potentially infected material in the vicinity of their properties. Removal of carcasses to distant burial sites contravenes the ban on movement of pigs within and from infected areas and sets a bad public example. Depopulation of pig farms should be immediately followed by cleaning and disinfection, with destruction of all material such as faeces, bedding and residual feed and cleaning and disinfection of water and feed troughs. Disinfection may be carried out with 2 percent sodium hypochlorite or a detergent-based virucidal agent. Teams should wear protective clothing and disinfect themselves, particularly their hands and boots, after operations.

Before destruction is attempted, owners must be assured of compensation at market-related prices. These prices must be determined by the price per kg that the pig would realize if sold normally. If possible, pigs should be weighed in the presence of owners to demonstrate the fairness of the price offered. Prices for different classes of pigs may be established but this gives rise to problems in countries where improved and local unimproved pig breeds are used, as the latter are much smaller and have a correspondingly lower market value. While overpayment

resulting from classifying 30 kg village pigs as 60 kg finishers will have a positive effect on owner cooperation, it will not be realistic in terms of the amount of money available for compensation.

PREVENTION OF MOVEMENT

This is the most difficult aspect of control. It is based upon:

- legislation with regard to control of animal diseases, particularly ASF, supported by the forces of the law, including veterinary authorities, police and army;
- cooperation by producers and the public to prevent movement when conventional methods fail;
- compensation for compulsory slaughter to avoid illegal movement and clandestine transactions.

Any national action plan should include innovative measures to support movement control, including participation of representatives of the pig industry in road blocks, dissemination of pamphlets and posters illustrating the consequences of illegal movement and incentives for reporting illegal movement that will outweigh the advantages of ignoring it.

SURVEILLANCE FOR ASF

This should be carried out by local animal health officers and agricultural extension officers, who should enlist the support of pig producers and village authorities and identify clear lines of reporting and communication. This is facilitated by holding public information days in infected foci and areas most likely to become infected. Records of pig farming that constitute the inventory of the national herd should be updated. All pig producers, especially in the areas surrounding infected foci, should be visited at least twice, with a two-week interval, to ensure that no untoward deaths have occurred. Veterinary officials versed in the clinical signs of ASF should carry out inspections at all livestock markets and abattoirs and question the sellers. They should have powers to detain pigs showing suspicious signs of disease or originating from farms that have experienced increased mortality or are situated in or close to infected areas. Blood and organs from slaughtered pigs may be submitted to the national diagnostic laboratory. Regular reporting and dissemination of information, for example by a weekly or bi-weekly epidemiological report, should be encouraged.

FIGURE 13



Sentinel animals

Sentinel animals need to be left to roam around previously infected premises to ensure that the disease agent is no longer present.

Surveillance may be reinforced by local, regional and national workshops on recognition and management of ASF. These should be held at regular intervals to ensure that new entrants are informed and trained. It is however, realistic to accept that considerable refreshment of past training will be required, especially in the absence of a disease over a long period.

STAND-DOWN PHASE

When ASF is not confirmed, the DVS should inform all parties that the emergency situation has ceased to exist. If ASF had been confirmed, the stand-down phase begins when the DVS is satisfied that all operations for containment, control and elimination of infected foci have achieved their goal. How soon this will occur after the initial outbreak will depend on circumstances, including whether other foci were discovered, their extent and the success of the stamping-out measures. In practice, if no further outbreaks have occurred for a two-month period after the initial outbreak, normal trade in pigs and pig products can be resumed, although this should be subject to veterinary surveillance for at least the first month or two. Sentinel pigs may be introduced into formerly infected premises 40 days after depopulation and disinfection. Failure of these pigs to develop signs of disease within two or three weeks of introduction will help to confirm that the outbreak has been controlled.

TRAINING, TESTING AND REVISION OF CONTINGENCY PLANS

SIMULATION EXERCISES

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

Realistic disease-outbreak scenarios should be devised for the exercises, using real data where possible for such elements as livestock locations, populations and trading routes. A scenario may cover one or more time phases during the outbreak, with a range of outcomes. Neither the scenario nor the exercise should be too complicated or long, however. It is best to test one system at a time, for example operation of a local disease control centre. Simulation exercises may be done as a paper exercise, through mock activities or a combination of both approaches. At the completion of each simulation exercise, there should be an assessment of the results. This review should identify areas where plans need to be modified and further training provided.

A full-scale disease outbreak simulation exercise should only be attempted after individual components of the disease control response have been tested and proved.

Exercises attempted before this has been done may be counterproductive. Care must be taken that simulation exercises are not confused with actual outbreaks by the media and the public.

TRAINING

Staff should be thoroughly trained in their roles, duties and responsibilities in an ASF emergency. More intensive training will need to be given to those who will be in key positions. It should 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. Backup staff should therefore be trained for each position.

THE NEED FOR REGULAR UPDATING OF ASF CONTINGENCY PLANS

Contingency plans should not be treated as static but as documents that regularly need reviewing and updating to reflect changing circumstances. In reviewing and updating ASF contingency plans, the following factors should be taken into account:

- changing epidemiological situations in and outside the country;
- new ASF threats;
- changes in livestock-production systems and internal and export trade requirements;
- changes in national legislation or in the structure or capabilities of government veterinary services or other government establishments;
- experiences in the country and neighbouring countries, results from training or simulation exercises and feedback from major stakeholders, including farmers.

OIE EXPERTS AND REFERENCE LABORATORIES FOR ASF

This list is valid as at the end of 1999. It may be subject to alteration in future years. The OIE should be consulted for their latest list of experts and reference laboratories.

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