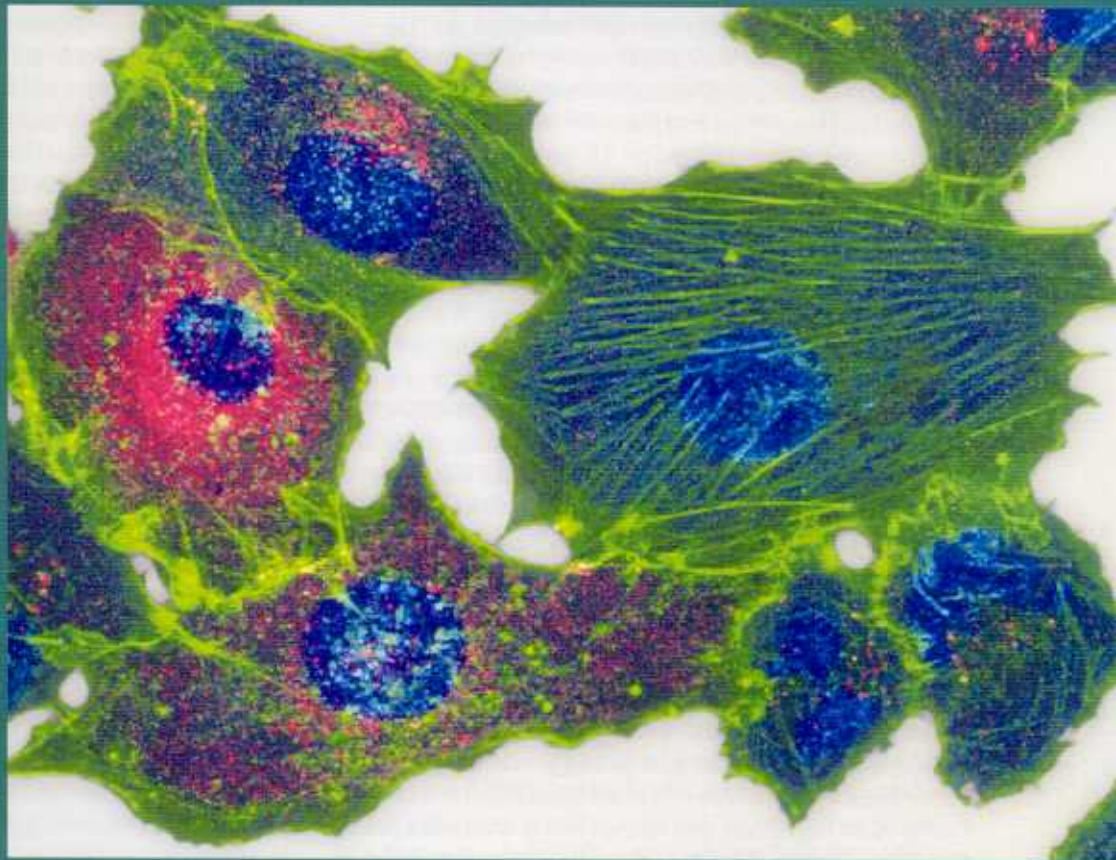


Infectious diseases in livestock

Summary and main recommendations



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Introduction

The 2001 outbreak of Foot and Mouth Disease (FMD) in Britain highlighted some major policy issues, which are the subject of numerous inquiries and reports. The Department for Environment, Food and Rural Affairs (DEFRA) and the Office of Science and Technology jointly commissioned the Royal Society to carry out one of these inquiries—an independent review, from a scientific standpoint, of how to prevent and combat further invasions of highly infectious livestock diseases, such as the 15 included in List A of the International Organisation of Epizootics (OIE). The review was strategic and wide-ranging, focusing on the current state of relevant scientific knowledge and its policy implications. It also highlighted gaps in that knowledge and the work required to fill them. The full report was published on 16 July 2002¹. This document summarises the main points of that report.

List A diseases are serious for animal health and for the economics of the livestock industry. While FMD is not normally fatal to adult cattle, pigs and sheep, it is debilitating and causes significant loss of productivity. In young animals it can be fatal on a large scale. It is one of the most infectious animal diseases, with huge quantities of virus particles being released and the disease spreading rapidly. So it is vital that the UK and its EU partners have a considered strategy for dealing with outbreaks of FMD and other List A diseases, and that this strategy be based on the best available science.

The Royal Society report was prepared by a Committee comprising scientists, veterinarians, farmers and experts in consumer affairs². The Committee issued a public call for evidence and received some 400 written submissions from individuals, the livestock industry and public- and private-sector organisations. We visited affected areas in Cumbria, Dumfries and Galloway, and Abergavenny, and held a public meeting in Carlisle. We also took oral evidence from many of those most affected by, or closely involved in managing, the outbreak. We have made the evidence publicly available on the Society's website [www.royalsoc.ac.uk] and on a CD-ROM enclosed with the full report.

Ten key findings

The overall objective of policy must be to minimise the risk of a disease entering the country and, if it does enter, to ensure the outbreak is localised and does not develop into an epidemic.

The UK, and the EU, should seek to retain '**disease-free status**' with respect to FMD and the other most serious infectious diseases. Under present circumstances, this status should be 'disease-free without (routine) vaccination'. But this proviso could change if, for example, the risk of an outbreak occurring increased sharply, better vaccines became available or the trading regulations associated with disease-free status were further changed, so it must be kept under active review.

Better **contingency planning** is vital. The Government must be empowered to act decisively during an outbreak. This requires prior debate about the control measures to be adopted. The Government's Contingency Plans should therefore be brought before Parliament for debate and approval. The Plans should be subject to a practical rehearsal each year and should be formally reviewed triennially to ensure that they take account of: the latest information about the scale of international disease threat; changes in farming practice; scientific and technological developments; regulatory developments at national, EU and global level; and the country's state of preparedness.

As a result of globalisation, the risk of invasion by exotic (ie non-endemic) animal diseases has increased. It is essential that the UK, and the EU, strengthen their **early warning systems** and ensure that warnings are acted upon. This requires an EU risk and surveillance unit; better funding for the OIE reference laboratories to track disease spread and identify the strains; heightened animal disease surveillance on farms; and greater interaction between farmers and veterinarians to improve the effectiveness of national surveillance. Import controls over meat products require tightening.

Routine vaccination against some of the most infectious diseases is possible. While there are no overwhelming scientific or economic reasons against this approach being adopted we believe that, at present, the considerable technical problems and the trade implications argue against changing current arrangements. Nevertheless it is clear that the long-term solution is to develop a vaccine against FMD (and other diseases such as classical swine fever) that confers lifelong sterile immunity against all strains of the virus. An international research effort is required to develop such a vaccine.

The **precautionary principle**—if in doubt, err on the side of caution—should be adopted more widely to ensure that any disease outbreak cannot develop into an epidemic. One of the most effective means of achieving

¹ *Infectious diseases in livestock*. London: The Royal Society, 2002. ppxiv, 160. Available from the Royal Society Publications Sales Department, price £25; also free of charge on the Society's website www.royalsoc.ac.uk/policy. A Science Brief, outlining some key facts and issues surrounding FMD for a general audience, may be found on www.royalsoc.ac.uk/scienceinsociety. ² The membership is given at the end of this document.

this is to minimise animal movements at all times. The Government should consider a system whereby early warning of infection triggers significantly enhanced precautionary measures.

Rapid culling of infected premises and known dangerous contacts, combined with movement control and rapid diagnosis, will remain essential to controlling FMD and most other highly infectious diseases. In many cases this will not be sufficient to guarantee that the outbreak does not develop into an epidemic. Given recent advances in vaccine science and improved trading regulations, **emergency vaccination** should now be considered as part of the control strategy from the start of any outbreak of FMD. By this we mean vaccination-to-live, under which meat and meat products from animals vaccinated and subsequently found to be uninfected may enter the normal human food chain (infected animals, of course, must not enter the food chain). The Government should prepare the regulatory framework and practical arrangements (eg validation of tests, and the supply of vaccines) that would allow this. There must at the outset be a strategy agreed among the main stakeholders to allow the country to return to the preferred 'disease-free without vaccination' status after the outbreak.

The first suspected case in an outbreak must be diagnosed in an approved OIE reference laboratory. Thereafter, **modern diagnostic methods** – including pen-side tests – need to be developed that can shift the burden of diagnosis to veterinarians on the farm. Rapid diagnosis, particularly before clinical signs appear, would limit the size of any epidemic and improve strategic deployment of resources. Such diagnostic methods must be linked by modern telecommunications to central headquarters.

There is considerable benefit to be gained from understanding the quantitative aspects of infectious disease dynamics. **Quantitative modelling** is one of the essential tools both for developing strategies in preparation for an outbreak and for predicting and evaluating the effectiveness of control policies during an outbreak. A prerequisite is a central database incorporating improved data on farms, the location of animals, animal movements, and the characteristics of the diseases, together with arrangements to input disease control data in a timely and assured way during an outbreak. More work is required to refine the existing models and to strengthen their capacity to inform policy, which in turn requires full access by researchers to this database and to the data on previous outbreaks.

A national strategy for **animal disease research** should be developed. The overall costs of animal diseases to the UK over the past 15 years may well have exceeded £15 billion: research is the only rational means available of improving animal health and diminishing disease. The strategy should be delivered through a 'virtual national centre for animal disease research and surveillance'

involving the Institute for Animal Health, the Veterinary Laboratories Agency and research groups in universities. It should also involve private research institutes and publicly funded animal disease research being undertaken in Northern Ireland and Scotland.

Synopsis of full report

The modern livestock industry

The total value of UK livestock production in 2000 was around £7.5 bn, a fall of over a quarter since 1996. Since 1967 the biggest changes have been a 40% fall in the dairy herd and a nearly 50% increase in beef. The sheep population has increased by 46% and broiler chickens by 180%, while the laying flock has fallen by about 60%. The average farm size has increased, and there are fewer individual farm holdings. These changes reflect a change in the public's eating habits and the improved efficiency of UK agricultural production.

Animal movements around the country are considerable and it is easy for disease to spread—as last year's outbreak showed. Ways to minimise movement need to be found, including wider application of 'standstill' quarantine arrangements and ensuring animals are slaughtered as close to the farm as possible.

The diseases

Domestic livestock have always suffered from a wide range of diseases. As livestock are concentrated in larger and larger numbers, the problems of major epidemics have become more severe. One response was the formation in 1924 of the OIE. The OIE set up an agreed international classification of diseases, with 15 in the most severe List A category and a further 80 in the less severe List B.

The Royal Society report concentrates, inevitably, on FMD, but also covers briefly a few of the more severe diseases in the OIE List A affecting each of the main livestock sectors, including: classical swine fever (CSF) (suffered very badly in The Netherlands in 1998, and in the UK in 2000); African swine fever; avian influenza; Newcastle (poultry) disease; bluetongue; and African horse sickness. Bluetongue, which particularly affects sheep, is transmitted by midges and is of special concern because of its northward progression, perhaps a result of global warming, which if current trends continue could bring it to the UK.

The trading dimension – the importance of 'disease-free' status

As a member of the EU and the World Trade Organisation (WTO), the UK is bound by the series of rules and regulations of those bodies designed both to protect free trade and to limit the international spread of disease. Central to those rules is the concept of the disease 'status' of countries. The UK has traditionally aspired to and maintained the highest level of animal health status,

namely 'Disease free without (routine) vaccination'. This enables the UK to trade with other nations that have a similar status. The evidence and advice we have received confirms our view that the UK should continue to strive for and maintain that status.

Surveillance and early warning

The threat of importing disease is high because of: high global demand for meat and meat products; extensive international travel and transport of meat and other foods around the world; improved transport routes; and climate change. A more recent risk is that of deliberate release of pathogens—bioterrorism. To forestall and meet the threat of importing disease, the UK must work with its international partners, both in Europe and more widely, to strengthen the present surveillance and early warning systems managed by the OIE and Food and Agriculture Organisation.

At the working level, farmers and veterinarians need to be more aware of the risks and more familiar with the symptoms of rarely encountered exotic diseases. Effective surveillance depends on close collaboration between farmers and their veterinarians, and between them and the State Veterinary Service (SVS). The SVS has become smaller in recent years. Farm animal disease surveillance needs to be strengthened. A major issue remains the poor understanding of how highly infectious exotic diseases are spread locally. This requires resolution through a targeted research initiative with the clear aim of improving standards of biosecurity at the farm level.

Modelling

Success in preparing for, and then handling, an outbreak of any infectious disease depends critically on having the right data – eg on the distribution of farms, their sizes and their livestock holdings – and using it effectively. Field epidemiology is essential for the vital detective work of tracking the spread of infection. Mathematical modelling of infectious diseases should be used between outbreaks to model and help prepare for different outbreak scenarios. Models can also be used when an outbreak occurs to predict the course of the outbreak and to estimate the effect of different control strategies, and thus to provide input to policy makers about the most effective control strategy for the specific disease and animal species involved.

Diagnosis

Because of the speed at which infectious diseases such as FMD can spread, the key to controlling an outbreak is to detect the disease at the earliest possible moment, and thereafter to diagnose infected animals as rapidly as possible. There is a high premium on being able to diagnose a disease even before clinical signs appear.

Recent developments offer good prospects for a 'pen-side' test that could be used by veterinarians in the field. Working devices exist, but still need to be internationally validated and further developed so that they are

sufficiently cheap and robust for regular use. When developed they should be linked electronically (eg by satellite link) to a central database that would hold all the results in an outbreak.

Vaccination

Routine vaccination has played a major role in controlling human and animal infectious diseases. It has led to the eradication of smallpox worldwide and the virtual elimination of rinderpest. There are many animal diseases where routine vaccination is the best control measure, and most animals in the food chain have been vaccinated. Routine FMD vaccination has never been used in the UK, but it was used by many other EU countries until 1991, when it was argued that the disease had ceased to be endemic and the risk of outbreaks had declined to such an extent that it was no longer the most cost-effective way to prevent outbreaks of the disease. The short length of conferred immunity and the large number of FMD strains were significant factors.

New developments in vaccine research and development should be applied to produce a vaccine capable of conferring lifelong sterile immunity against all strains of the FMD virus. With such a vaccine available it would be possible to change policies radically and introduce routine vaccination for all susceptible species.

During an outbreak, the short length of immunity conferred by current vaccines is less of a problem because it would normally still be longer than the outbreak. Moreover, it would be clear which specific FMD strain had to be countered. So emergency vaccination is a technical option.

Until recently, the main problem over the use of emergency vaccination has been the difficulty in distinguishing animals that have been infected but then recovered from those that have simply been vaccinated. The possibility of infection from the former is very low, but it led the OIE/WTO to impose a 12 month delay before a country that had used **emergency vaccination** could regain the status of 'disease free without vaccination'. This compared with a 3 month delay if culling alone had been used, and the additional 9 months delay was why emergency vaccination had always been considered a strategy of last resort. That was why the animals vaccinated in the 2001 FMD epidemic in The Netherlands were subsequently destroyed and did not enter the food chain.

Important advances have taken place within the last year – both technical and in the attitudes of the authorities and consumers – that should allow emergency vaccination to develop into a prime control strategy rather than one of last resort. It is now possible to distinguish vaccinated from vaccinated-infected animals. At its meeting in May 2002, the OIE therefore agreed to reduce the minimum period before a country can reapply for full trade status from 12 to 6 months, only 3 months longer than for culling-only control measures.

The following issues have to be solved before emergency vaccination can be introduced. With significant effort by DEFRA, this should be possible by the end of 2003.

- The policy should be vaccinate-to-live. This will necessitate clear acceptance by all concerned that meat and meat products from vaccinated animals may enter the food chain normally.
- Validation of the marker vaccines to be employed and the tests to distinguish between vaccinated and vaccinated-infected animals, and clear rules for defining the post-surveillance strategy for monitoring herds and flocks.
- Remaining trade implications both within and beyond the EU.
- The precise vaccination strategy to be employed, including the threshold criteria for its implementation when an outbreak occurs and the relative focus upon geographical regions, high risk farms or species to be vaccinated. Modelling should play a key role here.
- Practical issues concerned with storing vaccines, manufacturing extra vaccine stocks, delivery of vaccines and the training of vaccination teams.

Hence, we believe that the UK should now be planning to use emergency vaccination as an important component of its control strategy for FMD. Culling of infected premises and known dangerous contacts, and any other farms on which evidence of disease is subsequently found, will still be required, but emergency vaccination could be far more appropriate than the alternative of extensive culling.

Dealing with an outbreak

For the foreseeable future there is no alternative, when an outbreak occurs, to the rapid culling of diseased animals, and all those that are known, or very likely, to have been infected by them. Containing an outbreak rests upon speed of response. In the case of FMD, we envisage the response as involving these first steps.

- On suspicion of disease, impose local movement bans and send the index case to an OIE-reference laboratory for diagnosis.
- If confirmed, impose a national ban upon all livestock movements, standstill arrangements on all susceptible animals bought and sold (if not already in existence), and a 72 hour ban on any movements on and off farms within the restricted infected area by all vehicles and people except in extreme emergency.
- Instigate enhanced biosecurity at all levels, offering advice and support to achieve this.
- Deploy the national structures for handling potential disaster situations, including inter-Departmental coordination and provision of scientific advice and the specific command structures for FMD.
- Cull infected premises within 24 hours and all identified dangerous contacts within 48 hours.

If all these actions are taken rapidly enough, and environmental and farming conditions are favourable, then an outbreak may be contained. This is the historic and, in 2001, the initial approach within the UK. However, for some outbreaks additional measures are needed to stop the disease spreading and to eradicate the virus. In Britain this situation has developed five times over the last 80 years and in all cases the epidemics have proved extremely serious. Until far more is known about the mechanisms of local spread of the virus only two options exist for the 'additional measures': more extensive culling and emergency vaccination.

Under a culling-only strategy the aim is to get ahead of the disease by creating a 'firebreak' that will stop the virus spreading and allow the disease to die out. Inevitably this involves culling a larger geographical area than the dangerous contacts alone, and/or targeted culling of farms that are particularly at risk. During the 2001 UK outbreak this was achieved by culling contiguous premises, but in other outbreaks culling has focused on large dairy farms or pig units. If there is a likelihood of significant airborne spread of virus plumes, as occurred in 1967, extensive culling downwind may become necessary. In all these cases large numbers of animals rapidly become involved in the culling policy and major problems develop over logistics. In parallel, difficulties arise because of animals becoming trapped within restricted infected areas: there were major welfare culls associated with the 1997/98 CSF outbreak in The Netherlands and the 2001 FMD outbreak in the UK.

Emergency vaccination offers an attractive alternative to extensive culling. But, as discussed earlier, its implementation requires a number of issues to be resolved, not all of which are scientific or technical in nature. Once in place, however, we envisage emergency vaccination being employed at an early stage in an FMD outbreak so as to ensure it does not develop into an epidemic. The Government, in collaboration with its EU partners, should put in hand the work necessary to address the related issues identified above.

A strategy for dealing with an outbreak must include arrangements for returning to normal once the outbreak is over. Under a culling-only policy this involves extensive post-disease monitoring of herds and flocks for antibodies against the disease. When emergency vaccination is used, diagnostic tests must distinguish animals in herds and flocks that have been vaccinated from those that have also become infected. At this stage in the use of emergency vaccination we envisage that any flocks or herds found to contain animals that have been infected would be culled. Some applied research is still needed on the diagnostic tests, but the evidence indicates that they are adequate for the intended purpose. The aim, of course, is to return the country as soon as possible to the status of 'disease-free without vaccination' and full international trading.

Research

Worldwide, there is about one-tenth as much research on animal diseases as on human diseases. In the UK its funding from Government has declined, particularly through reductions in applied research commissioned by DEFRA. The quality of individual UK groups in general remains world class, and many of the OIE Reference Laboratories are in the UK. But the research is fragmented, and therefore not as effective as it could be. To bring greater coherence to the delivery of animal health R&D, a new National Centre for Animal Disease Research and Surveillance should be established – a ‘virtual’ centre, organisationally coherent but physically dispersed.

We support the Curry Commission’s call for a new ‘priorities board’ for research into farming and food matters, and we recommend that DEFRA develop a national strategy for research in animal disease, to give leadership, direction and coherence to the several agencies involved. This should cover both endemic and exotic infectious diseases.

An extra £250M is needed over the next ten years for recurrent expenditure to strengthen research groups and to provide expensive large containment animal research facilities. We recommend establishing university-based Research Units in specific areas complementary to those within the Institutes. These Units should be supported long-term (eg 10 years) and be subject to proper levels of funding and strict peer review.

Education, training and continuous professional development

The Government should work with the professional bodies to improve the education and training of farmers in infectious diseases of livestock and to investigate the subject and skill development priorities in the training of veterinarians.

Up-to-date training of veterinarians and farmers, and their continuous professional development, are important elements in disease awareness, prevention and control. We welcome DEFRA’s planned review of the effectiveness of training of farmers and land managers, and encourage action to improve their continuous professional development. In its work on veterinary education and training, the Royal College of Veterinary Surgeons should reflect on the experiences of the recent veterinary graduates pitched into dealing with the 2001 FMD outbreak.

Main recommendations

Our recommendations are addressed primarily to the UK Government. Control of exotic diseases is a devolved matter in Northern Ireland and Scotland and is subject to current discussions with the Welsh Assembly, and many of our recommendations should be read as applying both to DEFRA and to the equivalent ministries in Scotland and Wales. Our terms of reference cover Great Britain only but we hope that this report will be read by the Department

for Agriculture and Rural Affairs in Northern Ireland. The regulatory framework for disease control in animals is largely determined internationally – by the EU and, at the global level, by the OIE as part of the WTO framework. Some of our recommendations should therefore be considered also by these bodies.

Overview

The UK Government should bring before Parliament for debate a framework for the Contingency Plans covering the principles involved in handling outbreaks of infectious exotic diseases and the resources required for their implementation.

The Prime Minister should establish a formal procedure to review at three-yearly intervals:

- the level of threat from imported diseases of livestock;
- changes in livestock farming practices that could affect vulnerability to disease;
- scientific and therapeutic advances that could affect policy options;
- the UK’s, and Europe’s, state of preparedness.

The UK should continue to strive for ‘disease-free’ status against highly infectious diseases such as those listed in the OIE’s List A.

Providing the level of international threat does not increase; there are improved import controls; and there is a demonstrable improvement in the arrangements for handling disease outbreaks, the UK should not adopt a policy of routine vaccination, and should retain the internationally recognised status of ‘disease-free without vaccination’.

Diseases of livestock

DEFRA should:

- undertake a systematic analysis of the information available on the relative threats to the UK from the range of diseases covered here (and other significant disease such as transmissible spongiform encephalopathies and tuberculosis), taking account of the impact of globalisation and climate change, in order to set priorities for the national strategy for animal disease and surveillance;
- undertake a comprehensive review of the available information on FMD, and develop a consistent and coherent database of the basic information that would be required during an outbreak;
- carry out urgent research into local transmission of FMD that will improve biosecurity in the field.

Surveillance, biosecurity and livestock management

DEFRA should:

- propose an EU-wide risk assessment unit and centralised database on surveillance and disease data, and a review of the bodies that provide early warning of animal disease threats;
- promote the speedy implementation of their Action

Plan on illegal importing and of a much more coordinated approach at all levels by all bodies concerned with import control;

- investigate all the issues connected with reducing animal movements and come forward with practicable solutions that strike the optimal balance between the legitimate interests of livestock owners, market systems and long-term disease control;
- ensure that all keepers of livestock (including that not kept for food production) are properly registered and submit to DEFRA each year the name of their nominated private veterinary surgeon and a health plan approved by the same veterinary surgeon;
- establish an Applied Research Unit on Livestock Management Practices that will undertake or commission research leading to: (i) the design of effective biosecurity measures against infectious animal diseases; and (ii) the design of livestock management structures and practices that improve animal health in terms of infectious diseases.

Epidemiology, data and modelling

DEFRA should:

- establish a review to determine the data required for informing policy both before and during epidemics of infectious diseases. This review should involve all those likely to be involved with disease control, including modelling teams, and cover:
 - information to be collected on a routine basis, and how this can be kept up to date;
 - information to be collected during the outbreak;
 - incorporation of the data into a central database;
 - use of modern techniques for real-time data capture and verification;
- commission research to improve the methodology used to identify dangerous contacts;
- undertake a major research programme into the potential of mathematical modelling for understanding the quantitative aspects of animal disease dynamics. Mathematical models can be used both in preparing for outbreaks (including evaluating alternative strategies) and during the course of controlling an epidemic;
- ensure that the data from the 2001 epidemic are checked and then made widely available, while ensuring that any data protection issues are resolved.

Diagnosis

DEFRA should:

- ensure that sufficiently specific and sensitive pen-side antigen detection ELISAs are developed for FMD and other major diseases, are validated as quickly as possible, and are available on a large scale for use in the field, and that a similar ELISA is developed especially for detecting antibodies in sheep;
- explore the potential for portable RT-PCR machines for use in the field or at regional laboratories;
- develop advanced telecommunications between the field and central control;

• consider the benefits of providing responsibility for all List A diseases under a single organisation.

Vaccination

The Government should take the lead in developing an international research programme aimed at an improved vaccine that would permit routine and global vaccination of livestock against FMD and other List A diseases.

Emergency vaccination should be seen as a major tool of first resort, along with culling of infected premises and known dangerous contacts, for controlling FMD outbreaks. This policy should be vaccinate-to-live, which necessitates acceptance that meat and meat products from vaccinated animals enter the food chain normally.

In determining the arrangements for deploying emergency vaccination, DEFRA should:

- take account of the urgent need to achieve validation for field use of the tests that discriminate infected from vaccinated animals;
- develop emergency vaccination strategies that integrate theoretical and empirical epidemiology and the logistics of delivery of vaccine cover;
- establish a strategy for returning to normal after an outbreak that takes account of the need for ongoing surveillance, safeguards for those involved and agreement that products from vaccinated animals can enter the normal human food chain.

DEFRA should explore with the EU and OIE what improvements to vaccines and surveillance tests are required to allow disease-free status to be based entirely on surveillance results without the requirement for a minimum waiting period.

Dealing with an outbreak

The main objective in dealing with an outbreak must be to ensure that it does not develop into an epidemic. This requires the following basic measures:

- on **suspicion** of an outbreak, immediate imposition of strict local movement restrictions and biosecurity measures including culling the animal with clinical signs;
- on **confirmation** by an OIE Reference Laboratory of an outbreak:
 - mobilization of the full emergency arrangements including all additional logistic resources and the interdepartmental coordination and scientific advisory structure;
 - imposition of a total country-wide ban on animal movement with unambiguous and widely publicised advice on the fate of any animals in transit;
 - rapid culling of all infected premises;
 - identification and rapid culling of all premises where there is a high risk of the disease.

Where these measures are insufficient to guarantee that the outbreak will be contained, we recommend in addition the early deployment of emergency vaccination.

As a matter of urgency, DEFRA should draw up arrangements for a process for the prior registration for vaccination of zoos and rare breed collections.

DEFRA should review its arrangements for other diseases, and in particular the developments required to enable emergency vaccination to be used for CSF and bluetongue.

The detailed strategies for controlling outbreaks of livestock diseases should be included in the published contingency plan, which should consist of an umbrella plan for matters that are common to all diseases, with specific modules for each disease. These plans should be rehearsed in an annual 'fire drill' that must be realistic and involve DEFRA and all other relevant bodies including MoD.

Research and development, education and training

The Government should:

- undertake a thorough overhaul of research into animal disease, and in particular develop a national strategy for research in animal disease and surveillance;
- draw together the current research funding in

infectious diseases of animals (both endemic and exotic) within England into a single joint arrangement, the funds being made available to implement the national strategy;

- create a virtual national centre for Animal Disease Research and Surveillance, the Board of which would be responsible for delivering the national strategy;
- increase investment in animal disease research and development by the order of £250 million over the next 10 years.

DEFRA should take rapid action to investigate and improve:

- the continuous professional development of farmers and stock keepers;
- postgraduate training in livestock health and welfare;
- the attractiveness of careers within the State Veterinary Service;
- the training of temporary and local veterinary inspectors by DEFRA, with the RCVS, the BVA and its species divisions, investigating the feasibility of the BCVA proposals.

Membership of the Royal Society Committee on Infectious diseases in livestock

Sir Brian Follett, FRS, Chair

Mr Peter Allen, Farmer and member of the Council of the National Farmers Union

Professor Patrick Bateson, SecRS, Provost of Kings College Cambridge and Biological Secretary and Vice-President of the Royal Society

Mr David Black, Practising veterinarian in Cumbria

Professor Fred Brown, FRS, US Department of Agriculture, Plum Island Animal Disease Centre; formerly Deputy Director, Animal Virus Research Institute, Pirbright

Mr Roger Eddy, Senior Vice-President of the Royal College of Veterinary Surgeons, and practising veterinarian

Ms Suzi Leather, Deputy Chair, Food Standards Agency

Professor Simon Levin, Department of Ecology and Evolutionary Biology, Princeton University

Professor Karl Linklater, Principal, Scottish Agricultural College

Ms Jeanette Longfield, Coordinator of Sustain, The Alliance for Better Food and Farming

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Front cover picture: A confocal microscope image of foot-and-mouth disease virus infected cells, showing the disruption that the virus causes to the cellular actin filaments. Virus proteins are labelled in red, and actin in green. The nuclei are labelled in blue. Image © BBSRC, Institute for Animal Health, Pirbright Laboratory.