



RISK SOLUTIONS

FMD CBA Phase 2 - Integrated Findings Summary Report

A report for Defra

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1 Introduction

This report is a summary of the integration report which brings together the results of the epidemiological and economic modelling carried out between March and June 2003. This work supports the cost-benefit analysis (CBA) of standstill movement regimes, designed to control the spread of foot and mouth disease (FMD). Full descriptions of the approach and results can be found in the companion epidemiological^{1, 2} and economic³ project reports. The work addressed zero, 6 and 20-day standstill control regimes in full, and other standstill regimes in part.

The benefits of the regimes are measured in terms of the reduction in size and the associated cost of potential future outbreaks. The cost is the annual year on year cost of implementing the regimes.

2 Approaches

2.1 Epidemiological Modelling

The purpose of movement standstill controls is to limit the “silent spread” stage of a virus outbreak, i.e. in the time after incursion and before the first case is definitely confirmed, so before emergency contingency measures such as a national movement ban, animal culling etc. come into operation.

In Phase 2 of the cost/benefit analysis project it was possible to both improve the Silent Spread model by Risk Solutions used in Phase 1 and to adapt another model, Massey’s InterSpread Plus, to assess the impact of standstill controls. Using two independent approaches helps provide confidence where it is impossible to fully validate the models.

The results of this work can be summarised as follows:

- Standstill regimes help limit disease spread, with mean size of outbreak reducing as the standstills get longer. They cannot, however, prevent large outbreaks occurring though they do reduce the likelihood of the bigger outbreaks.
- Increasing length of standstill has greatest effect on large outbreaks and scenarios with long times to detection.

¹ FMD CBA Phase 2 Epidemiological Modelling Project Report – The Silent Spread Model, Risk Solutions, Issue 2, June 2003

² Evaluation of Livestock Standstill Policies for Foot and Mouth Disease in Great Britain, Veterinary Laboratories Agency, Weybridge and EpiCentre, Massey University, Palmerston North, June 2003

³ FMD: Animal Movement Regime-CBA, PHASE 2, Economics component, Veterinary Epidemiology and Economics Research Unit (VEERU), School of Agriculture, Policy and Development University of Reading, Final Report 10th June 2003

- The overall size of the outbreak under any standstill regime is very sensitive to:
 - Time to detection
 - Location of outbreak.

These factors can have greater impact than length of standstill.

These results are entirely consistent with the Phase 1 findings and we found that results generated using InterSpread Plus and Silent Spread were broadly comparable. The extent and nature of the agreement is such that we can be confident that we have gained a good understanding of how standstill regimes act to limit disease spread.

The modeling contains a number of broad assumptions and limitations; we do not believe that any of these invalidate these conclusions.

2.2 Economic Modelling

The economic assessment, carried out by a consortium led by Reading University's Veterinary Epidemiology and Economics Research Unit (VEERU), derived economic measures of the costs of the standstill control regimes and the benefits they can provide. The analysis was conducted on the basis of the impact of the policy on the national economy. Opportunity costs of goods and services were measured by their value in their best (most valuable) alternative use. Internal domestic financial transfers between sectors were excluded. Taxes and subsidies were omitted from the analysis except where transfers to and from the European Union are involved.

2.2.1 Costs of Control Regime

The costs of implementing the control regime were estimated on the basis of a farm level survey stratified by 12 different main farm types, and five different holding size groups.

Costs considered included costs (or savings) of delay (or advances) to sales or purchases and costs (or savings) associated with changes in marketing and purchasing methods. No off farm costs have been included, partly because many of these are transfers and also because of the difficulty of establishing accurate costs for these. Time constraints prevented the inclusion of costs to the Government and Local Authorities of implementing the animal movement standstill policies.

The total annual cost of implementing the 20-day standstill is estimated using this methodology at £22.9 million. The cost of the 6-day standstill is estimated at £8.4 million.

Given the time limitations the sample size of the survey was necessarily small, 150 farms in England and 100 in each of Scotland and Wales. The analysis is based on estimating a mean cost of the regimes. In fact the majority of farmers report no impact from the standstills and the means are therefore driven by a few farmers sometimes reporting very high costs⁴. Farmers had little or no experience of the 6-day regime and VEERU warn about the need to be particularly cautious in the use of this figure.

⁴ In the survey, the average gross annual cost of the 20-day standstill regime per farm holding varied from zero to £1040. Overall, 61% of surveyed farms in England reported no additional costs. In Wales the figure was 54%, and in Scotland 84%.

Given these uncertainties VEERU have established an alternative cost for the 6-day regime of £6.5 million that they propose as a suitable value for use in a sensitivity analysis. This still remains much higher than the Phase 1 estimate of £3.4 million, which was made on the basis of a theoretical calculation.

2.2.2 Benefits of the Standstills

Cost estimates for each outbreak scenario, are based on the analysis of the costs of the 2001 FMD outbreak given in the report by the Comptroller and Auditor General (2002) (Total: £3030 million).⁵ These costs have been modified and adapted in the light of careful review of the assumptions made in these analyses and the likely effects of the contingency plans now in force. Details of the revised cost estimates are given in the VEERU report.

VEERU have provided costs of outbreaks for two scenarios as shown in the table.

Table 1: Cost of Outbreak for Two Scenarios

Cost of Outbreak (£ millions) Scenario	c.21 days time to detection, high movement frequencies		
	0-day	6-day	20-day
Ayrshire	257	206	86
Staffordshire	967	637	273

From this we can derive the following unit costs:

Table 2: Unit costs of outbreak in £

Cost per IP (Government costs, tourism costs etc)	£ 942,742 (based on scaled 2001 outbreak)		
	cattle	Pigs	Sheep
Cost per animal culled	£ 725	£ 106	£ 63
Cost per animal culled (after 12.3% EU rebate)	£ 636	£ 93	£ 55

There is a great deal of uncertainty in these cost estimates, but one particular difficulty is in determining which costs to include relating to the impact on the tourist industry. VEERU have proposed two alternative estimates for a 2001 sized outbreak of £595 million and £1.93 billion respectively. Carry-over effects into the years following an epidemic have not been incorporated in the present analysis.

2.3 The Integration Framework

The epidemiological and economic modelling have been brought together within an integration framework. This combines the results of numerous scenarios into an overall cost benefit assessment.

⁵ *The 2001 Outbreak of Foot and Mouth Disease*, Report by the Comptroller and Auditor General, House of Commons, 21 June 2002, Thompson *et al* 2002

Some key features of the approach include

Use of Full Range Data - Disease incursion and spread is a complex process involving many random variables. We cannot know when the next outbreak will occur or how large it will be. We can however determine the range of possible outcomes. The integration framework allows the impact of this variability on the CBA to be explored.

Treatment of frequency of outbreak - There is great uncertainty regarding the timing of the next outbreak and there is always the chance of an outbreak happening next year, so we have used a probabilistic approach to the time of the next outbreak. We have carried out successive calculations assuming outbreaks occur at mean frequencies of up to 1 in 40 years.

Use of discounting - Discounting is a way of taking into account the time value of money. We have used discounted cash flows, to compare the whole life cost and benefit to cost ratio of standstill regimes in present value terms.

Epidemiological scenarios - We have assigned each region in mainland Britain to one of 3 “integration areas” defined according to the density of farms with susceptible species (sheep, cattle and pigs). The probability of an outbreak in each area depends on the method of incursion, and is estimated on the basis of the distribution of outdoor pigs and small to medium sized pig farms.

Measures used in the CBA calculations - When the effect of discounting is taken into consideration, we have two basic measures of the attractiveness (or otherwise) of standstill regimes:

1. The Whole Life Discounted Cost
2. The Net Benefit to Cost Ratio

The former provides a measure of the overall cost to the economy of each of the regimes, taking into account both the cost of the regime and the cost of any outbreaks that occur under the regime. The preferred option using this measure minimises this cost.

The latter is a measure of return per unit cost invested. If this number is less than one then the option costs more than the monetary value of the benefit, although there may be other benefits to consider. The preferred option using this measure is the one that maximises the ratio.

3 Integration Findings

3.1.1 Choice of epidemiological inputs to the CBA

It was decided to use InterSpread Plus data rather than Silent Spread data in the final analysis, for two main reasons: (i) The InterSpread Plus results probably represent a more short term reaction to the livestock movement controls rather than a situation where farmers had adapted their long term behaviour; this is closer to the circumstances explored by the VEERU economic survey, and (ii) Silent Spread data would need to be scaled to the end of the epidemic if it were to be used in the integration framework, thus introducing additional uncertainty.

3.1.2 Choice of Case Studies

The analysis is characterised by a great deal of uncertainty. In this summary report we have presented findings from 3 of the case studies that are representative of the range of the results. The complete set of case studies can be found in our full length Integration report.

The three case studies presented here are defined as follows:

Case No	Movement frequency	Time to detection	Cost of outbreak	Cost of regime	Likelihood of outbreak region
1	Average	21 days	Tourism - Low	6d - £8.4m	By pigs only
2	Average	14 days	Tourism - Low	6d - £8.4m	By pigs only
7	Average	21 days	Tourism - High	6d - £6.5m	By pigs only

A fundamental and very significant uncertainty is the frequency with which future outbreaks are expected to occur. The impact of varying this parameter has been explored in each case.

3.1.3 Analysis based on Mean Outcomes

The figures below illustrate the significant effect that the assumed frequency of outbreaks has on the attractiveness of standstill regimes. Each graph shows the **mean value** of the whole life discounted cost for each standstill regime.

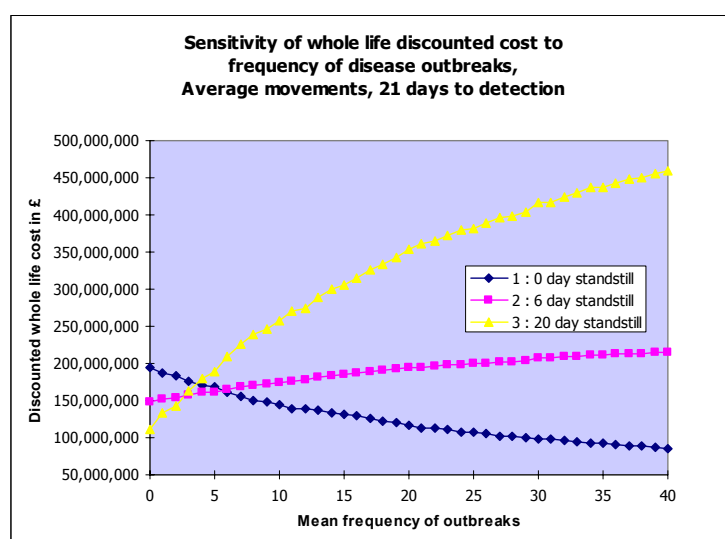


Figure 1a: Case 1

Under these conditions, the 20-day regime only results in the lowest mean discounted whole life cost at outbreak frequencies of 1 in 3 years or less. Beyond 1 in 5 years, the zero day regime has the lowest cost.

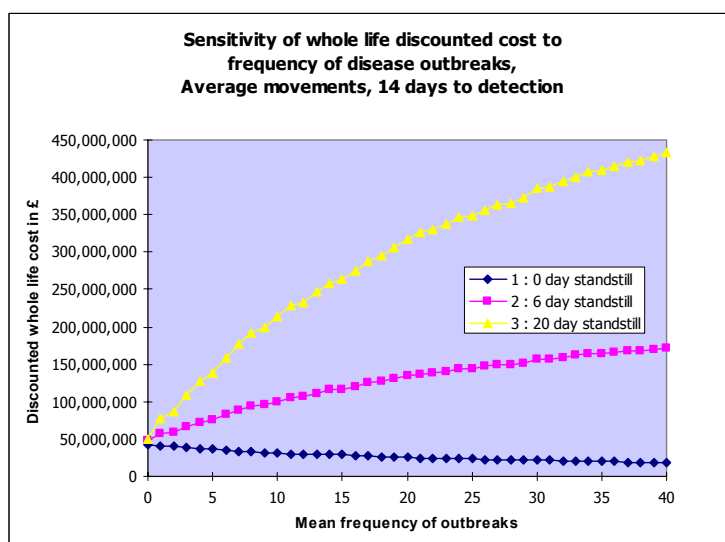


Figure 1b: Case 2

Under these conditions the zero day regime has the lowest mean cost for all outbreak frequencies, so standstill regimes are never justified based on mean behaviour.

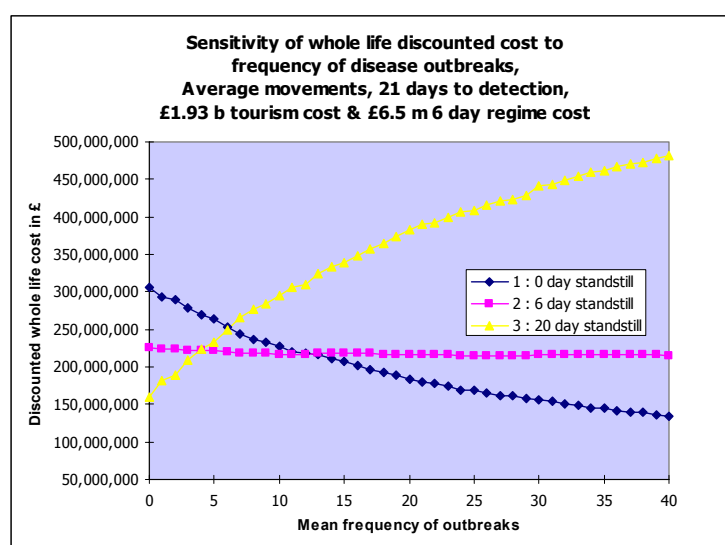


Figure 1c: Case 7

Taking the alternative values for both tourism and the 6-day regime we find the “cross-over” point for 0 and 6 day standstills has moved out to a mean outbreak frequency of about 1 in 12 years, i.e. justifying a 6 day standstill at a frequency of 1 in 12

Summary of mean outcome analysis

From the graphs we can see that:

1. The zero day regime becomes less and less expensive as the outbreak frequency gets less frequent, as the only cost involved is the cost of the outbreak, which is being discounted by a larger and larger amount the further into the future it occurs.
2. The 20-day regime gets more and more expensive as the outbreak frequency gets less frequent, as the whole life cost is dominated by the accumulating annual cost of the standstill regime.
3. Standstill regimes look justified at a mean outbreak frequency of about 1 in 12 years or lower.
4. Overall, the 6-day regime appears to be the least sensitive to outbreak frequency as the 6-day curves are relatively flat compared to the others under all of the above scenarios. This is because the increasing value of the accumulating standstill regime costs, discounted back to the present day, is more or less balanced by the decreasing value of the outbreak costs as the outbreak gets further into the future. In some respects therefore, the 6-day regime is behaving like an “insurance policy” by avoiding the very high costs of extreme outbreaks under a zero day regime **and** the very high costs of a 20-day regime at long outbreak frequencies.

3.1.4 Analysis of distribution of outcomes

In this section the distribution of possible outcomes is illustrated using box and whisker plots. In these plots, the red whiskers represent the 5th and 95th percentiles, the white box represents 25th and 75th percentiles, and the black bar is the distribution mean.

Case 1 Results

Movement frequency	Time to detection	Cost of outbreak	Cost of regime	Likelihood of outbreak region
Average	21 days	Tourism - Low	6d - £8.4m	By pigs only

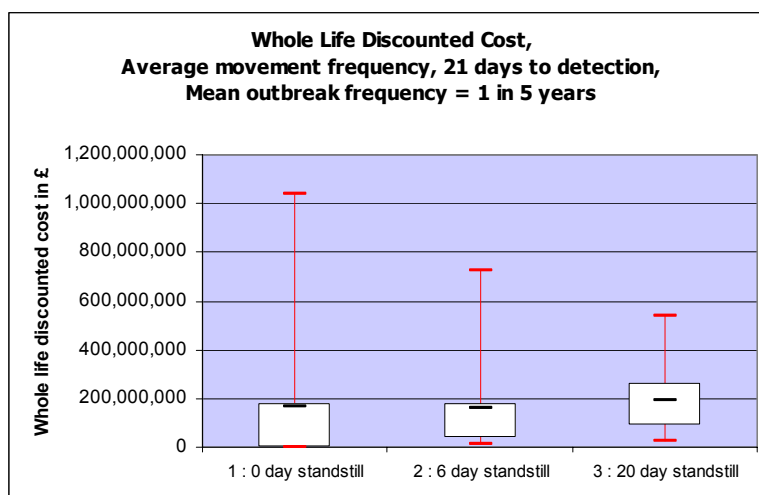


Figure 2a

At a mean outbreak frequency of 1 in 5 years, the 6-day regime has the lowest mean cost, although all regimes are quite close to each other. However the probability of an extremely high cost (resulting from a very large outbreak) reduces considerably as the regime is increased from zero to 6 to 20-days.

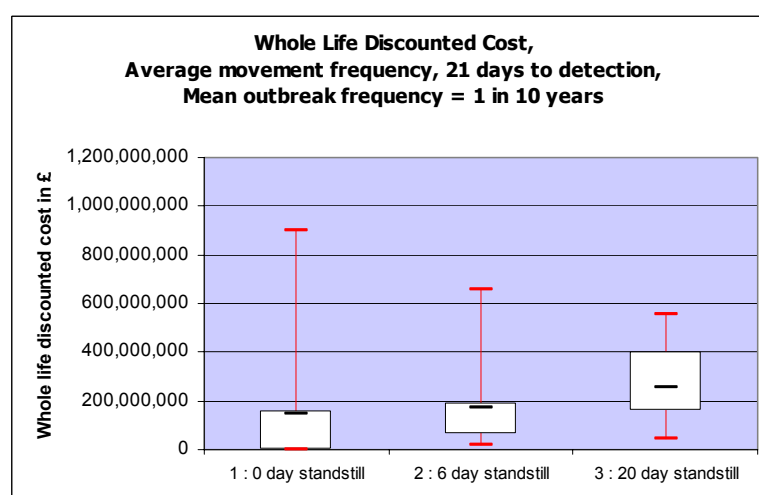


Figure 2b

At a mean outbreak frequency of 1 in 10 years, the zero day regime has the lowest mean cost. However at the 95%ile level there is still an increasing benefit to be obtained moving from 0 to 6 to 20-days.

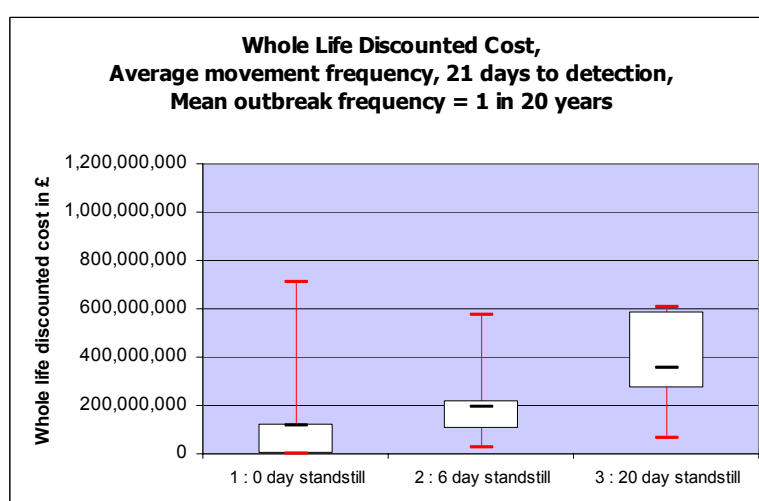


Figure 2c

At 1 in 20 years the mean cost of a 20-day regime is considerably higher than the 6-day or 0-day case. The 6-day regime continues to offer benefits over the 0-day standstill at the 95%ile but there is no additional benefit to be gained from the 20-day regime. At the 25-75%ile level the 20-day regime is considerably more expensive than either the 6-day or the 0-day regime as the white boxes

no longer overlap at all.

Summary of distribution analysis

In the distribution analysis we have looked at the probability distribution of outcomes at 3 discrete mean outbreak frequencies: 1 in 5 years, 1 in 10 years and 1 in 20 years. In almost all the case studies we looked at we find:

- At mean outbreak frequencies of 1 in 10 years and 1 in 5 years the 0-day and 6-day 25-75%ile ranges overlap quite a lot, although there are still differences in the mean values.
- At 1 in 20 years, the degree of overlap between the 0 and 6-day 25-75%ile ranges has reduced; however the 20-day regime is clearly more expensive. Once the outbreak frequency reaches 1 on 20 years there is a high probability that the 20-day standstill will be a very expensive option.
- At the 95%ile, the standstills provide significant benefits over the 0-day standstill even at a mean outbreak frequency of 1 in 20 years reducing exposure to high cost, low probability outcomes.

The exception to the above is where the mean time to detection is reduced to 14 days. Here the standstill regimes offer no benefit over the 0-day standstill even were outbreaks as frequent as 1 in 5 years.

3.1.5 Net benefit to cost ratio

The net benefit to cost ratio provides a measure of the return per unit investment in the control regime.

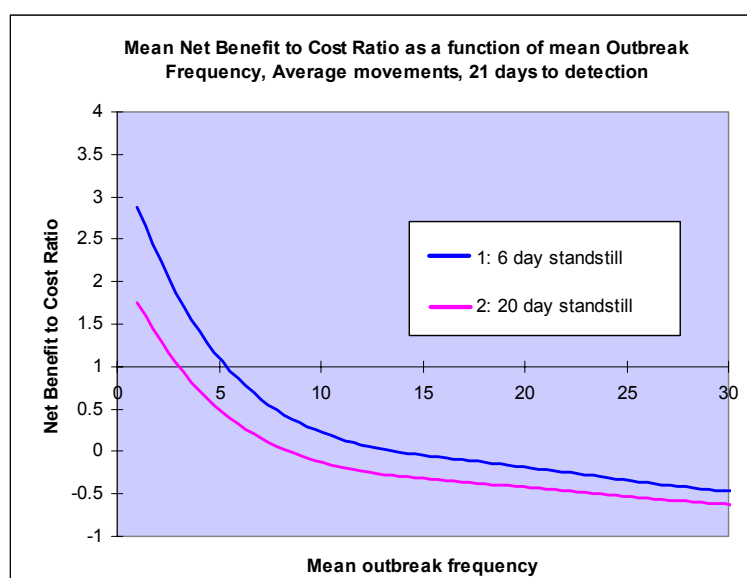


Figure 3: Sensitivity of mean value of net benefit to cost ratio to mean outbreak frequency, average movements, 21 days to detection

The figure shows that the mean value of the net benefit to cost ratio is only greater than 1.0 for outbreak frequencies shorter than about 1 in 5 years for the 6-day regime, and about 1 in 3 years for the 20-day regime.

The 6-day regime everywhere yields a higher return than the 20-day regime, measured by the net benefit to cost ratio.

4 Conclusions

4.1 Behaviour under mean conditions

We find that under the set of reasonable assumptions considered here, if decisions are to be made on the mean value outputs from our analyses, standstill controls are justified if outbreaks are expected to occur at a mean frequency of around 1 in 12 years or more frequently. The 6-day standstill is generally the preferred regime; the 20-day standstill regime is only justified if the mean outbreak frequency is around 1 in 5 years or more frequently.

4.2 Behaviour under extreme conditions

Standstill regimes are most effective at capping the total whole life discounted cost of very large outbreaks (at the 95%ile level). The 6-day regime shows the lowest overall sensitivity to outbreak frequency, so in some respects it acts like an “insurance policy” by avoiding the very high costs of extreme outbreaks under a zero day regime and the very high costs of a 20-day regime if long outbreak frequencies are realised.

4.3 Effect of sensitivity studies

Various sensitivity studies have been examined. Of all of these, measures to shorten the time to disease detection has the biggest effect on the size of outbreaks (and therefore on the cost benefit case for standstills), but overall none of the sensitivity studies alter the basic conclusions in Sections 4.1 and 4.2.

Factors that potentially have an impact on the results but have not been varied include:

1. Contingency response - The InterSpread Plus base case runs assume that the contingency response would build up quite quickly in the event of an outbreak, in line with the Defra provided assumptions.
2. Exemptions – these have not been modelled
3. Non-compliance with standstill regimes– this was not included in the InterSpread Plus model, although it was found to be of secondary importance in the analysis done using the Silent Spread model.

4.4 Other factors

The costs and benefits of standstill controls should also be considered in the context of:

1. Complimentary control measures that may offer more benefit at the same or reduced cost, such as measures to increase the efficiency of disease detection and reporting.
2. Other less tangible costs of the standstills, such as loss of flexibility for farmers, social impacts etc.
3. Other benefits of standstills, such as the part they may play in the control of other diseases.