



M.bovis under a microscope

TB Eradication Programme – Badger control in the IAPA project decision paper

Title of Paper: Fumigation as a badger culling technique decision paper (Ref: WI-IAPA-W-Dec-A-02 v 1.3)

Submitted to: TB Eradication Programme Board

Submitted By: Programme Management Office

Date:

For Decision

Subject:

This paper is presented to the board for a decision on the pursuance of a research programme to develop the fumigation of badger setts as a culling technique.

This paper provides an overview of previous fumigation control policies, recent research programmes and requirements to develop fumigation as a culling technique.

Also attached is:

Appendix B.

1. Review of effectiveness, environmental impact, humanness, and feasibility of lethal methods for badger control. Defra 2005.
2. Overview of research into carbon monoxide fumigation as a method of culling badgers to prevent the spread of bovine tuberculosis. Defra 2008.



M.bovis under a microscope

TB Eradication Programme – Badger control in the IAPA project decision paper

Fumigation as a badger culling technique decision paper

Reference No. :

Author : TB team

Owner : Dafydd Glyn

**Welsh Assembly Government
Cathays Park
Cardiff
CF10 3NQ**



TB Eradication Programme – Badger control in the IAPA project decision paper

M.bovis under a microscope

Contents

1. Purpose of Decision Paper	4
2. Scope of project	4
3. Project Definition	4
4. Current Position	5
5. Governance	8
6. Current Delivery Mechanisms	9
7. Financial Position/Costs	9
8. Current Performance	10
9. Recommendations	10
Appendices	12
Appendix A: Document Control	13
Appendix B: Supplementary documents	14



TB Eradication Programme – Badger control in the IAPA project decision paper

M.bovis under a microscope

1. Purpose of Decision Paper

This paper seeks a decision from the Programme Board with regards to the recommendations at section 9 below and within the papers referenced at Appendix B.

2. Scope of project

The fumigation of badger setts has been proposed as a potential method of culling badgers. This paper aims to set out the information required for the Programme Board to consider the validity of pursuing a research programme into developing fumigation as a badger culling technique. This will be achieved by summarising the extent of previous research and by describing further work that would need to be carried out to develop fumigation as a culling method. This decision paper will summarise the humaneness, environmental impact, effectiveness and feasibility of fumigation as a control strategy. Information on alternative techniques of culling badgers will be presented in a separate decision paper. However, as fumigation is repeatedly proposed as a suitable culling technique to control badgers and the fact that there are no licensed fumigants, a separate decision paper is required.

3. Project Definition

As part of the 'One Wales' document, the Welsh Assembly Government has committed to 'vigorously pursue a programme of bovine TB eradication'. An additional £27.7m of funding has been allocated over the next three financial years to support this commitment.

The eradication programme will consider all aspects of bovine TB policy, including cattle surveillance and controls, wildlife measures and husbandry practices including improved biosecurity.

This decision paper comprises part of the wildlife component of the programme, which aims to remove the link between badgers and cattle in the transmission of bovine TB (TB). This involves considering badger culling in an Intensive Action Pilot area (IAPA). In order to identify an effective technique of culling it is important that all potential techniques are considered and that culling is considered along with alternative methods of badger control.

The objectives for this work are:

- Review previous fumigation policies.
- Review previous research on fumigation.
- Describe the research requirements to develop fumigation as a culling technique.
- Describe the feasibility of fumigation as a culling technique.



TB Eradication Programme – Badger control in the IAPA project decision paper

M.bovis under a microscope

4. Current Position

Fumigation of badger setts with hydrogen cyanide (HCN) was used as a control strategy between 1975 and 1982. However, it was replaced with trapping in 1982, primarily, as a result of animal welfare issues, but there was also concern about ineffective dispersal throughout the sett. A number of fumigants have been investigated as potential replacements for HCN, with carbon monoxide currently being considered to be the most humane.

There are a number of factors that determine the suitability of fumigation as a control method. Principally the fumigant has to be deemed humane, which depends on:

- i) The effects of exposure to a lethal concentration of the gas.
- ii) The risk of animals only being exposed to sub-lethal concentrations of a gas.
- iii) The consequences of sub-lethal exposure.

The success of fumigation also depends on the ability to deliver a lethal concentration throughout the badger sett, which is affected by the diffusion characteristics of the gas, the structure of the sett and the nature of the substrate.

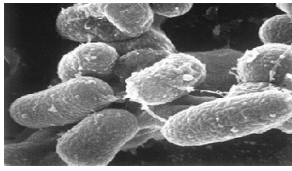
Fumigation of setts involves either pumping gas into the sett or relying on diffusion. Diffusion is used when the gas is produced from tablets or powders deposited into the sett entrance. Although diffuse fumigation requires less equipment it is unlikely that the gas would distribute evenly throughout the sett. The effectiveness of fumigation depends on the ability to achieve a lethal dose throughout the sett, which will vary according to the characteristics of the gas, rate of input, topography, volume of the sett and the characteristics of the surrounding substrate. The behaviour of badgers may also influence gas dispersal, as badgers may evade the gas by moving deeper into the sett.

Badger setts can be large and complicated with many entrances and interconnected tunnels, as well as a number of blind ending tunnels and nesting chambers. In addition, some setts initially identified as large may in fact be composed of several separate setts with no interconnecting tunnels. An added complexity in estimating the size of a badger sett is that they are often found in woods or dense undergrowth, which makes it difficult to detect all entrances. There is no method for assessing the complexity of sett structure. The little information on sett structure highlights the variation with the volume of setts ranging from between 0.7m³ to 38.3m³. Of particular concern is the proportion of blind-ended tunnels, in which it is unlikely that gas will fully disperse and blind-ended tunnels may comprise a significant proportion of the sett. This issue led Defra to conclude that

“Due to the complexity of badger setts it is unlikely that a lethal concentration of any of the agents discussed below would always occur throughout the whole of a sett, which is also suggested from theoretical models and experimental data on burrow fumigation on other animals”¹.

A substantial amount of modelling and experimental work has been carried out in an attempt to determine levels of gas dispersal in a badger sett. The modelling work used computational fluid dynamics (CFD) to model gas dispersal under a range of conditions, such as different gas production methods, sett structure and soil substrate. This work indicated

¹ Review of effectiveness, environmental impact, humaneness and feasibility of lethal methods for badger control. Defra 2005.



TB Eradication Programme – Badger control in the IAPA project decision paper

M.bovis under a microscope

that target concentrations were rarely achieved. However, physical experiments, which involved measuring gas concentrations along a simple artificial tunnel, showed that target concentrations could be reached. This discrepancy in results meant that neither modelling work nor the data from physical experiments could be used to predict gas dispersal in more structurally complex setts. Further work suggested that it might be possible to reconcile results from models and experiments, although it was concluded that obtaining lethal concentrations throughout complex setts may be difficult.

Effective control by fumigation relies on all individuals in a social group being killed with a single application, but this may not always be possible if setts are large, inaccessible or some individuals may be absent. Wet and windy weather conditions may also prevent fumigation. The efficacy of fumigation is often unpredictable and is unlikely to achieve more than an 80% reduction of the resident population. Repeating the application may improve the success of fumigation although this is unlikely to lead to 100% removal. Earlier gassing strategies relied on repeated applications and although a large proportion of the social group was removed, it was difficult to assess efficiency.

There is an additional risk that fumigation may impact on non-target species that share badger setts. Species that have been reported to share badger setts include foxes, rabbits, wood mice, bank voles, otters, feral cats, weasels, polecats, and brown rats, but this list is likely to be incomplete. Fumigation of active badger setts may minimise the risk to non-target species, but there is no quantitative information on non-target species inhabiting badger setts and no reliable method for determining if non-target species are current inhabitants. The fumigants described below are unlikely to have other environmental impacts as they disperse over time and do not persist in the bodies of killed animals.

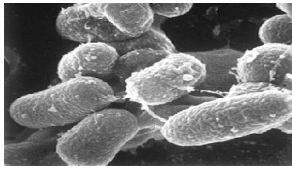
A number of gases have been considered as potential fumigants. These are phosphine, hydrogen cyanide, carbon dioxide and carbon monoxide.

Phosphine

- The toxicity of phosphine to badgers is unknown, although phosphine can cause severe suffering in other animals.
- Operators would have to wear personal protective equipment (ppe), including gloves and respirators.
- Fumigation is not to be carried out in wet or windy weather.
- Phosphine is currently registered for use against moles and rabbits in the UK.
- Phosphine is considered to be inhumane as well as a dangerous poison.

Hydrogen cyanide (HCN)

- Toxicity of HCN to badgers comes from experiments on 4 badgers. The effects varied according to the level and duration of dose, with 1 badger dying and 3 recovering.
- Operators would have to wear ppe, including gloves and respirators. If operators are unable to smell HCN they should not carry out the operation.
- Fumigation is not to be carried out in wet and windy conditions.
- HCN is highly toxic to aquatic organisms and fumigation should not be carried out in areas where it may leach into groundwater.
- HCN did not readily disperse through tunnel systems.
- HCN is considered to be moderately humane, although fumigation of setts ended in 1982 due to welfare concerns.
- HCN is not currently licensed for use as a pesticide.



TB Eradication Programme – Badger control in the IAPA project decision paper

M.bovis under a microscope

Carbon dioxide (CO₂)

- The response of badgers to CO₂ is unknown.
- Badgers may be relatively tolerant to high CO₂.
- Mink, which are related to badgers, are averse to CO₂.
- Minimal environmental impacts will result from fumigation with CO₂.
- CO₂ is currently licensed as a pesticide for use in specific circumstances against mice, rats and birds.
- Minimum estimates indicate that 440kg worth of cylinders would be required to fumigate one large sett.
- Humaneness of CO₂ is currently under review by the Home Office as a humane method of euthanasia for laboratory animals, and will be withdrawn for use in rabbits.

Carbon monoxide (CO)

- The response of badgers to CO is unknown.
- Badgers, particularly neonates may be relatively tolerant to CO.
- There is a risk of brain damage with sub-lethal doses.
- Minimal environmental impacts will result from fumigation with CO.
- There is minimal risk to operators and no ppe is required.
- Fumigation may not be possible in windy conditions.
- CO can be produced in a variety of ways, although an engine-based fumigator has been identified as the most feasible. Currently, there are no commercially available methods of producing CO that guarantee a constant output, although a commercial device is currently under development*.
- The secondary gases emitted during CO production may increase toxicity and/or decrease humaneness.
- CO is not currently licensed as a vertebrate pesticide.
- Carbon monoxide is a relatively humane fumigation candidate.

Based on feasibility and humaneness, CO has been identified as the best potential fumigant for use against badgers.

Work required to develop CO as a fumigant

(This is a brief overview and there is likely to be a great amount of detailed work behind each point. It is not possible to determine the timescales or costs involved in this work as no research organisations are willing to trial CO as a fumigant against badgers in the field without first undertaking lengthy and extensive experimental studies under rigorously controlled conditions requiring specialist facilities and licencing under the Animals (Scientific Procedures) Act. The potential net benefit with respect to welfare would need to be demonstrated in advance of undertaking such studies and it is thus by no means certain that such licences would be granted.

).

- Generate data to cover physical chemistry, mammalian toxicology, environmental fate and behaviour, ecotoxicity, efficacy and humaneness for a licenced product.
 - The above would involve assessing the toxicity of CO to badgers.
 - This is required for legislative purposes (see 3.1).
- Welfare assessment of CO fumigation under field conditions.
 - Determination of likelihood of sub-lethal doses being delivered. This may involve both modelling exercises and practical experiments.



TB Eradication Programme – Badger control in the IAPA project decision paper

M.bovis under a microscope

- Impact of sub-lethal doses on badgers.
- Develop a standard and reliable method of CO production.
 - Develop a commercially viable unit that is capable of producing the required level of CO*.
 - Assess the toxicity of additional pollutants that are generated during CO production.
- Register CO as an approved vertebrate control agent.
 - Identify company to develop CO as a fumigant and take it through the legislative procedures. Therefore, it has to be commercially viable.

*A prototype portable CO generator, with an increased output of CO, is being developed in Australia for use against rabbits. This unit is not yet commercially available.

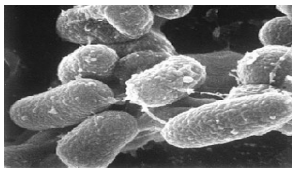
5. Governance

The European Union legal framework on bovine TB is formed by legislation, the first of which, Directive 64/432/EEC, is aimed at facilitating intra community trade among the EU Member States by establishing comparable health requirements. An important extension of this is Council Directive 77/391/EEC, which introduces Community measures for the eradication of brucellosis, leukosis and importantly tuberculosis in Cattle. This requires Member States to develop eradication programmes in order to accelerate, intensify or carry through the eradication of TB. Article 3 (2) (a) of Council Directive 77/391/EEC states:

“...plans for accelerating the eradication of bovine Tuberculosis shall be so devised that on their completion herds are classed as “officially TB free” in accordance with community provisions in this field and Directive 64/432/EEC in particular.”

While we cannot, with any ease, change our obligations under EU law the Welsh Assembly Government has wide powers to make Orders under the Animal Health Act 1981 for the better execution of the legislation or for the purposes of preventing the spreading of disease. The Tuberculosis (Wales) Order 2006 was enacted using the provisions of the Act. The definition of ‘disease’ under section 88(1) of the Act specifies TB as being a disease covered by the Act.

- Legislation that covers the development and use of CO as a fumigant to control badgers:
 - Home Office Licence would be required to carry out research on captive badgers. This would be held by the organisation carrying out the research.
 - Food and Environmental Protection Act requires pesticide to be approved by either the Biocidal Products Directive (BPD) or Control of Pesticides Regulations (COPR).
 - Biocidal Products Directive would apply if CO were to be supplied as a biocide.
 - Control of Pesticides Regulations would apply if CO were to be used as a biocide.
 - Protection of Badgers Act (PoBA) licence would be required to kill, take and interfere.
 - Wildlife and Countryside Act (WCA) licence would be required to use a prohibited method.
 - Animal by Products Regulation requires that all carcasses would be treated as Category 1 material and therefore require collection and incineration.



TB Eradication Programme – Badger control in the IAPA project decision paper

M.bovis under a microscope

- Policy / Ownership
 - A policy to fumigate badgers would have to be owned, developed and managed by the Welsh Assembly.
 - The Health and Safety Executive would be responsible for approving CO as a fumigant.
 - A research organisation would be required to develop CO as a fumigant and then take it through the licensing procedure.
 - The Welsh Assembly Government would be responsible for issuing and assessing licenses under PoBA and WCA. License requirements would have to be developed.
- Operational/Delivery responsibility
 - The Welsh Assembly Government would have to assume responsibility for monitoring and evaluating the effectiveness of a fumigation strategy.
 - Fumigation could be carried out by a variety of responsible bodies (see 3.2).

6. Current Delivery Mechanisms

- Government
 - The Welsh Assembly may be responsible for delivery through a team of trained personal or contract the work out to pest control specialists.
- Farming Industry (Farmers or farming organisations)
 - Farmers or farming organisations may be responsible for delivery as individuals acting collectively or contract the work out to pest control specialists.
- Veterinary Profession
 - Vets are most likely to play an advisory role in development and implementation of fumigation.
- Research Organisation
 - A research organisation would be required to develop CO as a fumigant.

7. Financial Position/Costs

At this stage it is not possible to determine all the costs that would be required to develop CO as a fumigant, except to say that it would require substantial funds. Section 3.0 provides details of the main components that would require funding and each component is likely to require several hundred thousand pounds. For example, it is likely to cost around £250,000 to go through the license CO as a vertebrate control agent (excluding collection of required data). A useful comparison to make is that the use of strychnine to kill moles has now fallen by the wayside, as it was not commercially viable for industry to support it through the Biocidal Products Directive even though this was an important niche use. The advice from the Health and Safety Executive, who would be the UK Competent Authority carrying out the assessment is

“In relation to companies who may be willing to help take this forwards, in reality they will be looking to the commercial aspects for themselves as the costs for supporting an active substance through either system can be quite high - and the costs of generating the necessary data itself even higher - so for such a niche use as this I can't imagine they will be that willing”.



TB Eradication Programme – Badger control in the IAPA project decision paper

M.bovis under a microscope

Information from commercial companies on collection of data packages for development of new and more humane alternatives to anticoagulants for rodents suggest of a figure of £1 million per substance. In addition to the experimental data for the licencing package further trials would be required for a more thorough welfare assessment. These trials have been estimated at costing in the region of £1 million.

The operational costs of fumigation, based on Defra personnel carrying out operations have been estimated by Defra to be around £2,462 per km². Cost-benefit analyses indicate that this method of control would need to prevent 60% of cattle TB incidents to break even. This is thought to be unachievable and thus this method of control was not considered worthwhile.

8. Current Performance

The information presented in this report was principally obtained from a 'Review of effectiveness, environmental impact, humaneness and feasibility of lethal methods for badger control' (Defra 2005, <http://www.defra.gov.uk/animalh/tb/abouttb/badgers.htm>).

- Main Benefits:
 - There appear to be no benefits of pursuing a research programme into fumigation of badger setts with CO or other fumigants.
- Main Issues:
 - It is highly unlikely that a method can be developed to deliver a lethal dose throughout a badger sett.
 - There are no humane fumigants currently licensed as general vertebrate control agents.
 - There is no reliable and standard method of producing CO, the only fumigant considered to be relatively humane.
 - The effect of CO on badgers is unknown, particularly the effects of sub-lethal doses.
 - There are considerable costs involved in developing CO as a fumigant.
 - There is also an issue of time, as it may take a year to license a product, which excludes the time taken to generate required data and carry out practical experiments on delivery.

There are no research organisations in the UK that are willing to support or carry out trials CO as a fumigant against badgers in the field without first undertaking lengthy and extensive experimental studies under rigorously controlled conditions.

All research organisations capable of carrying out field evaluation in badgers were contacted and all declined to offer advice or discuss the potential opportunity for such evaluation.

-
- Fumigation of badger setts is unlikely to improve culling efficiency.

9. Recommendations

This reports highlights the main issues that need to be resolved if CO is to be used to control badgers. It is obvious that there are considerable practical and financial obstacles to using CO as a fumigant, not least the fact that it will be impossible to guarantee that a lethal dose is delivered to all animals in a sett. Additionally, no research organisations in the UK are currently willing to carry out field evaluation of CO as fumigant for badgers. The 4 research organisations with the facilities to carry out this type of research in the UK were contacted and all 4 declined to be involved.



TB Eradication Programme – Badger control in the IAPA project decision paper

M.bovis under a microscope

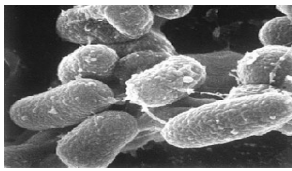
The fumigation of badger setts is unlikely to improve culling efficiency or increase benefits in terms of disease control compared to other methods. Thus, this decision paper recommends that fumigation is not pursued further as a badger control strategy. However, the potential use of CO as a fumigant will be monitored. Alternative measures to control badger populations will be presented in a decision paper when the programme board will be asked to make a decision on control strategies.



M.bovis under a microscope

TB Eradication Programme – Badger control in the IAPA project decision paper

Appendices



TB Eradication Programme – Badger control in the IAPA project decision paper

M.bovis under a microscope

Appendix A: Document Control

Version History

Version	Date	Comments
1.0	06/10/08	Draft completed by Iain Trewby
1.1	20/10/08	Comments added by Dafydd Glyn
1.2	13/10/08	Comments added by Dafydd Glyn
1.3	14/10/08	Comments added by Christianne Glossop
1.4	12/12/08	Comments added by Central Science Laboratory (CSL)

Document Distribution

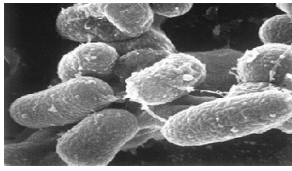
Name	Location	Responsibility	Action / Information
Christianne Glossop	Cardiff	Chief Vet	Review
Dafydd Glyn	Cardiff	Policy Manager	Review
Mark Alexander	Cardiff	Programme Manager	Review
Tom Henderson	Cardiff	Project Manager	Review
Rob Brown	Carmarthen	Programme Office	Review
CSL	Sand Hutton	Technical review	Review

Document Reviewed By

Name	Location	Responsibility
Dafydd Glyn	Cardiff	Policy Manager
Rob Brown	Carmarthen	Programme Office
CSL	Sand Hutton	Technical review

Source File Location

P:\Woad\APHPD\TB\BovineTB Eradication Programme\Programme Management\Governance\Programme Board\



M.bovis under a microscope

TB Eradication Programme – Badger control in the IAPA project decision paper

Appendix B: Supplementary documents

1. Review of effectiveness, environmental impact, humanness, and feasibility of lethal methods for badger control. Defra 2005 (attached pdf).
2. Overview of research into carbon monoxide fumigation as a method of culling badgers to prevent the spread of bovine tuberculosis. Defra 2008 (attached pdf).