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New controls on methyl bromide: UK impact study. Structural and commodity uses (NRI report no. 2392)

NATURAL RESOURCES INSTITUTE

New controls on methyl bromide

UK Impact Study

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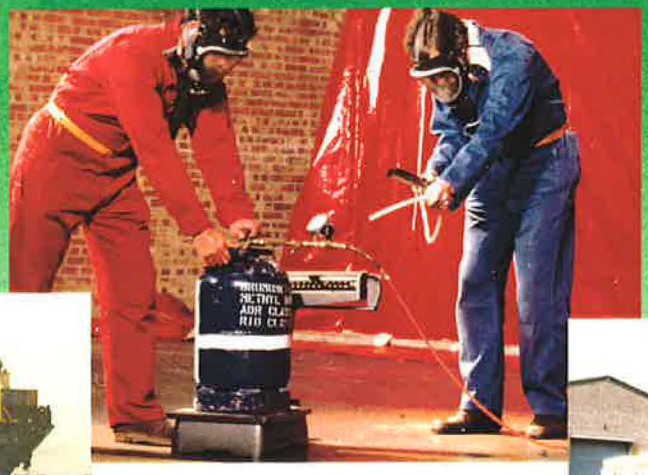

Report prepared for the UK Department of the Environment, Transport and the Regions, and the Ministry of Agriculture, Fisheries and Food

NRI
Natural Resources Institute

the UNIVERSITY of GREENWICH

Report No. 2392

New Controls on Methyl Bromide: UK Impact Study

Structural and Commodity Uses

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Contents

Executive Summary

DETR and MAFF commissioned NRI to research the UK impacts of the phaseout of methyl bromide as a structural and commodity fumigant. Industry compliance costs and the technical feasibility of three control scenarios were the main areas of investigation.

1. Quantities of Methyl Bromide Used.

The annual quantity of methyl bromide used in the UK for structural and commodity fumigations is approximately 200 tonnes, representing about 40% of UK uses excluding that for chemical feedstock. In 1997, uses were:

- Flour mills (approximately 76 tonnes per annum)
- Commodity imports (approximately 46 tonnes per annum) including commodities in containers and stacks. The major commodities that are regularly fumigated with methyl bromide in the UK are rice, cocoa, dried fruit, nuts and coffee.
- Exporters who require fumigations to comply with pre-shipment regulations of foreign countries (approximately 35 tonnes per annum)
- Buildings other than flour mills (approximately 18 tonnes)
- UK quarantine of timber and plant cuttings (approximately 1 tonne)
- Ships, for control of rodents under quarantine requirements (approximately 8 tonnes)
- Aircraft, principally to control rodents (approximately 0.7 tonnes)
- Unspecified uses (approximately 15 tonnes)

2. Control Scenario and Enforcement Issues

Table 1. Control scenarios

Scenario A		
2001	100%	Cut with critical use exemptions meeting the criteria at Annex A, but no exemption for quarantine and pre-shipment
Scenario B		
2001	50% cut	With an exemption for all quarantine and pre-shipment uses as defined in Annex C.
2003	70% cut	
2005	100% cut	With critical use exemption meeting the criteria at Annex A and an exemption for all quarantine and pre-shipment uses as defined in Annex C.
Scenario C		
2001	75% cut	With an exemption for all quarantine and pre-shipment uses as defined in Annex C,
2005	100% cut	With critical use exemptions meeting the criteria at Annex A and an exemption for all quarantine and pre-shipment uses as defined in Annex C.

The controls in scenario A include a complete phaseout of methyl bromide from the market after 1/1/2001, and removal of the quarantine and pre-shipment exemption. Only emergency and critical use exemptions will be permitted. If very few commodity and structural, critical, and emergency use exemptions are granted, fumigation companies may be unable or unwilling to conduct methyl bromide fumigations. In this event, exemptions may become meaningless.

Control scenario B represents measures required by the Montreal Protocol and includes a 50% supply reduction in 2001 (based on 1991 levels), followed by a 70% reduction in 2003, and finally a complete phaseout in 2005. Control scenario C includes a 75% supply reduction in 2001 and a complete phaseout in 2005. Quarantine, pre-shipment, critical use and emergency exemptions would be permitted under both scenarios. These scenarios would create a sellers' market for methyl bromide and prices would increase. However, given that firstly, structural and commodity users would be able to outbid horticultural users, secondly, pre-shipment and quarantine exemptions would be granted, and thirdly, modest progress is made towards reducing reliance on methyl bromide, sufficient quantities of methyl bromide would be available for structural and commodity fumigations.

There is the possibility, particularly under scenario B, that prolonged phase-out will discourage early action and simply delay compliance costs until 2005.

To a large extent, the methyl bromide supply and fumigation industries are self-regulating. The only external monitoring comes from the Health and Safety Executive (HSE), which makes occasional inspections to ensure that methyl bromide is used safely and only for the purposes for which it is registered.

If supply remains in the hands of a few reputable companies, controlling the supply of methyl bromide onto the market will not create significant enforcement difficulties for the public sector. As yet there is no agreement on which public authority would monitor supplies, and grant and police exemptions.

3. Imported Commodities

All the imported commodities that will be significantly affected by the methyl bromide phaseout are fumigated at origin prior to export to the UK. In many cases, poor fumigation standards and careless pre-shipment handling create the need for re-fumigation on arrival in the UK. Large commodity importers are well placed to improve pest control and fumigation at origin, but with few exceptions, they have opted for the simple and wasteful expedient of re-fumigating on arrival. Improving practices at origin requires considerable initial commitment but given the alternatives, the rewards will probably prove very attractive to commodity importers when methyl bromide is phased out.

A sensible approach to improving pest control at origin would involve co-operation within or even across commodity sectors. Concerted sectoral action could reduce costs to individual importers, reduce the time before significant results are achieved, and help promote long term sustainability.

More commodity fumigations are conducted in the UK than are strictly necessary. The ease and low cost of methyl bromide fumigations has encouraged some companies to adopt blanket fumigation policies. If commercial players were to make greater use of commodity inspectors, this would avoid unnecessary fumigations.

Control scenario A: If commodity importers do not succeed in improving fumigation practices in countries of production, they will be forced to rely on phosphine. This will have two effects, each caused by the longer periods required for phosphine fumigations. The effects are:

- Congestion: Many commodity fumigations are currently conducted either in containers at ports or in stacks in warehouses. Already congested, the UK's ports will be unable to accommodate containers for extended periods. Congestion in ports will spill-over into the warehousing sector, which will already be experiencing congestion problems of its own. In the worst case, a crisis of insufficient space could develop. Further work is required to establish the likelihood of this occurring.

- Incremental costs of working capital, insurance and storage: In cases where normal UK stockholding is insufficient to absorb longer fumigation periods, the working capital cost of holding increased stocks will be high. Extra stocks will also attract storage and insurance costs.

Companies that run the risk of incurring significant compliance costs after 1/1/2001 are in the cocoa, dried fruit, coffee, rice and nuts industries (Table S1). Importers of tobacco, herbs, spices, cotton, and cereals other than rice, will be either minimally or not affected by the phaseout of methyl bromide.

Table S1: Estimated Compliance Costs for Commodity Importing Industries in the First Year After the Introduction of Control Scenario A

Industry	Incremental cost **Low Estimate (£)**	Incremental cost **High Estimate (£)**	Range of high and low estimates as % of annual import value
Cocoa	242,000	393,000	0.10 – 0.17
Dried Fruit	231,000	347,000	0.15 – 0.20
Rice	107,000	189,000	0.08 – 0.14
Nuts	71,000	105,000	0.04 – 0.06
Coffee	18,000	54,000	0.02 – 0.02

* Figures have been estimated using different assumptions on how quickly importers will reduce the frequency of re-fumigations in the UK.

Table S1 summarises the estimated incremental costs that UK commodity importing industries will bear in the first year after the restrictions of scenario A take effect. Costs in subsequent years are assumed to be substantially lower because industries will react by putting much greater effort into improving practices at origin. Ultimately, annual compliance costs will be close to zero.

The figures in Table S1 include incremental costs of working capital, storage, insurance, transport, handling, and fumigation. They do not include costs of improving practices at origin. These will be highly dependent on the extent of UK industry co-operation, and the pressure that commodity industries from other developed countries would exert at origin. Costs would ultimately be offset by the reduction or elimination of re-fumigation in the UK.

Control Scenarios B and C: The costs of complying with controls suggested under these scenarios will be minimal compared with costs under scenario A.

Critical use exemptions: Under the proposed EC criteria, NRI sees no clear cases for critical use exemptions for imported commodities.

4. Structural fumigation - flour mills

Opinions of pest-control experts are divided as to the ability of flour millers to cope without critical use exceptions after the year 2000. The authors' view is that they can

probably manage with IPM regimes up to 2003 or thereabouts, by which time the industry may have identified an acceptable alternative involving the use of heat, with or without modified atmospheres and inert dusts. However, due to remaining technological uncertainties, there is a finite risk under Scenario A that infestation will reach unacceptable levels in one or more mills.

The analysis indicates that, in order to comply with the controls on methyl bromide, increased costs would range between £8.4 million and £67 million to cover the costs of increased downtime, increased silo storage capacity, and the incremental costs of pest control measures over several years. The high cost projection takes account of the potential need to use a heat-based treatment in addition to cleaning and other pest control measures.

These projections apply to all three scenarios, but costs will be borne earlier under Scenario A than under Scenario C, and even earlier than under Scenario B. Moreover, Scenarios B and C give the industry more opportunity to find ways of reducing compliance costs, for example through the introduction of new gaseous insecticides.

We suggest no exemptions up to December 31, 2002, because fumigations with methyl bromide that are permitted during the year 2000 could provide a two-year leeway, after which exemptions could be granted if specified conditions are met, i.e. there being a significant risk to food safety, and due effort having been taken to prevent infestation through other means. All such exemptions might be eliminated by the year 2005 by which time it is expected that alternatives to methyl bromide fumigation will become available. Compliance costs are likely to be higher in relation to turnover for smaller than for larger milling companies.

5. Structural fumigation - other food-processing industries

Similar considerations apply to maize-milling as to flour-milling. Most rice-millers still use methyl bromide, but we expect them to experience little difficulty in coping with the phase-out; incremental costs will be correspondingly minimal. Food processors in general have made much more progress than millers have in implementing IPM regimes, and we expect that the phase-out will accentuate this change, again with minimal cost implications. Cheese manufacturers are a notable exception, due to unusual temperature and moisture conditions required for maturation; a critical use exception may be needed to cover certain categories of cheese.

6. Other important impacts

Aircraft fumigations: Although this usage is small (0.7 tonnes in 1997), it has great importance. Fumigations are designed to kill rodents that would otherwise destroy aircraft electronic systems. The need to take swift action once rodents have been detected is therefore very important. In the UK, the only alternative to methyl bromide fumigation is baiting. Current baiting technology requires aircraft to be out of service for approximately five days. Preliminary information suggests that the cost of keeping an aircraft on the ground for this period is at least £2,000,000. Once controls on methyl

bromide have been introduced, aircraft fumigations may not qualify for critical use exemptions under the criteria proposed by the Commission. However, in view of public safety and costs to airlines, NRI believes that a strong case could be made for a special use exemption. Pressure could still be applied to airline companies to find alternatives.

Fumigation of infestible wooden materials for export to Australia and New Zealand: In order to prevent the introduction of forestry pests, Australian and New Zealand quarantine regulations require that imports containing infestible wooden materials, including pallets and packing materials, should be treated against pests in the country of origin. In the UK, goods and packaging are usually fumigated in export containers using methyl bromide. NRI estimate that over 8,000 containers were treated in this way in 1997. If no quarantine and pre-shipment exemptions are permitted once methyl bromide controls are introduced (such as under scenario A), exporters will be forced to use non-infestible packaging materials and in some instances, may have to divert or cease exports. The planned registration of an alternative fumigant called Vikane would ease the situation.

Other pre-shipment fumigations: Pre-shipment regulations in countries other than Australia and New Zealand also occasionally require methyl bromide fumigations. NRI estimates that in 1997, 5,000 export containers were fumigated in the UK to comply with these regulations. NRI was unable to calculate costs of compliance due to the diversity of exports and countries of destination.

Fumigation of imported plant cuttings: The chrysanthemum cuttings import trade uses approximately 40kg of methyl bromide per annum to comply with UK plant quarantine regulations. If no quarantine exemptions are permitted once methyl bromide is withdrawn, imports of chrysanthemum cuttings from countries that are unable to provide credible phytosanitary certificates will have to cease.

Disinfestation of artefacts: A small quantity of methyl bromide continues to be used by those museums that have not adopted alternative methods for disinfesting artefacts. However, the impact on those museums of phaseout of methyl bromide, even under control scenario A, should not present a problem technically, because alternatives to methyl bromide fumigation are available. A problem may exist where the adoption of alternatives has not been budgeted for by 2001.

Pest control companies: Overall, the fumigation service industry will gain from the phaseout of methyl bromide. The major companies have already started preparing for new business in alternative pest control services. However, under control scenario A, some small specialist companies may liquidate.

7. Compliance Costs versus Ozone Depleting Potential

Table S2: Compliance Costs and Ozone Depleting Potentials Under Scenario A

Industry	Annual ODP	Annual inc. cost/ODP **Low estimate (£/tonne)**	Annual inc. cost/ ODP **High estimate (£/tonne)**
Cocoa importing	9	*28,000	*45,000
Dried fruit importing	7.2	*34,000	*50,000
Rice importing	9.6	*11,000	*20,000
Nut importing	1.2	*35,000	*52,000
Coffee importing	0.6	*23,000	*69,000
Flour milling	45.6	48,000	222,000

* Figures correspond to costs in the first year of scenario A. Costs in subsequent years are assumed to be lower. Figures do not include the costs of improving pest control in countries of origin.

Table S2 compares compliance costs with the Ozone Depleting Potential (ODP) of methyl bromide. The comparison is made for most of the structural and commodity methyl bromide users that will be significantly affected by the controls suggested under control scenario A. A notable omission is pre-shipment fumigations of exports to Australia and New Zealand. NRI was unable to gather sufficiently detailed information to estimate the relevant compliance costs.

The ozone-depleting potential (ODP) used to calculate the costs in Table S2 is 0.6, as currently agreed under the Montreal Protocol.

1. Introduction and Background

Introduction

1. The European Commission has proposed amendments to an EC Council regulation that controls the production and supply of ozone depleting substances. The impetus for change comes from (i) continuing scientific evidence of ozone depletion and the adverse effects this has on human health and ecosystems (ii) technological advances in the development of alternatives to ozone depleting substances, and (iii) the requirement to implement strengthened international controls under the Montreal Protocol.

2. The Commission has proposed controls that go beyond the phase-out requirements of the Montreal Protocol. These controls include the production and consumption of methyl bromide in the EU from 1 January 2001. Supplies of this chemical for its use as a fumigant will only be permitted, after phase-out, for a few critical and emergency uses.

3. The Department of Environment Transport and Regions (DETR) and the Ministry of Agriculture Food and Fisheries (MAFF) commissioned the Natural Resources Institute (NRI) to research the impacts in the UK of the phaseout of methyl bromide as a structural and commodity fumigant. The terms of reference for the research required NRI to focus on the following factors:

- Economic implications, including compliance costs
- Environmental benefits
- Technical feasibility
- Enforcement practicalities

4. As a result of discussions between DETR, MAFF and NRI, it was agreed that the study would focus on the economic implications, compliance costs to industry, and technical feasibility. Environmental benefits and enforcement practicalities were also considered. Under technical feasibility, NRI examined the practicality of alternatives to methyl bromide fumigation, uses where no alternative exists, and the development or introduction of new technologies.

5. NRI was asked to compare three options for methyl bromide phaseout (see Table 1., Executive Summary). Scenario A sets out the Commission's proposals. Scenario B represents controls required by the Montreal Protocol and therefore represents the minimum restrictions that the EC can introduce. Scenario C is a possible compromise between scenario A and the Montreal Protocol controls.

Current Uses of Methyl Bromide for Durable Commodities and Structures

6. Methyl bromide has been used as a fumigant in the UK for more than 50 years to control insect pests damaging food commodities. In addition, the structures used for storage, transport and processing are often fumigated in order to reduce the risk of cross contamination into commodities. Treatments with methyl bromide can be completed in a relatively short period, usually 24 or 48 hours, which is a distinct advantage in situations where time is a constraining factor, such as at ports, or in flour mills, and where delays are likely to result in additional costs. Methyl bromide has a broad spectrum of activity against the range of insects that damage stored products, and is effective in controlling all developmental stages even at the low temperatures occurring in winter in the UK. The gas, which boils at 4°C, is stored as a liquid under pressure in cylinders and is released immediately as required. These properties of methyl bromide are major reasons why the fumigant has continued to be used over a long period during which several other fumigant gases have fallen into disuse.

7. Major structural and commodity uses for methyl bromide include the disinfestation of mills and food processing factories, disinfestation of commodities to be exported (often to satisfy quarantine regulations at destination), and of commodities found to be infested on arrival at UK ports, typically cocoa, coffee, dried fruit, nuts and rice. There are, in addition, some minor uses for methyl bromide which, although the quantities involved are very small, are nevertheless very important. These include the fumigation for quarantine purposes of imported plant cuttings and of newly developed varieties of plants prior to export, the disinfestation of aircraft and ships to control rodents and insects, and the treatment of artefacts and museum specimens.

8. There are a few disadvantages associated with methyl bromide, not least that the gas is more than three times heavier than air. This causes methyl bromide to accumulate at the bottom of treated enclosures making mechanical circulation necessary in some situations. Methyl bromide is also sorbed significantly by some types of commodity making it essential to adjust application rates accordingly in order to maintain a lethal concentration in the intergranular space. There are no recorded instances of insect resistance to methyl bromide from field applications which is a distinct advantage compared with phosphine, a major alternative, and to which insect resistance has developed.

Technical Alternatives to Methyl Bromide Fumigation

Phosphine

9. Metal phosphides generating phosphine (hydrogen phosphide) have been used world-wide for at least 20 years, and are registered in most countries. Phosphine is the preferred fumigant for disinfesting commodities in warm climates where time is not a constraint. The gas is most widely obtained from solid preparations of aluminium or magnesium phosphide placed in the fumigation enclosure. These preparations produce phosphine by reaction with water vapour on exposure to the air. Complete production of the gas may take several days depending on the temperature.

Magnesium phosphide reacts more quickly than aluminium phosphide after release, and is especially useful in cool climates. Recent technical developments are likely to make on-site generation of gas available in the future, particularly for large-scale treatments.

10. A major feature of phosphine is its relatively slow toxic action to insects. Even at temperatures of 20°C, or greater, fumigation exposure periods of at least five days are recommended. Phosphine, is generally considered to be more suited for use in warm climates with a minimum commodity temperature of 15°C often being recommended. Under UK conditions, phosphine is most effective during the summer months although it can be used in winter temperatures. However, longer fumigation periods are necessary and it is essential to ensure that enclosures being treated are extremely gas-tight. Typical conditions under which a 24-hour fumigation employing methyl bromide may be successful may not, however, be sufficiently gas tight to maintain lethal concentrations of phosphine in treatments lasting for several days.

11. Phosphine is effective against a broad range of insect pests, it penetrates well into commodities (better than methyl bromide) and, being only very slightly heavier than air, disperses rapidly and completely throughout enclosures being treated. There is little sorption of phosphine by most commodities and application rates are chosen on the basis of the situation rather than on the commodity. In addition to the long fumigation period necessary with phosphine there are several other disadvantages of the fumigant. Phosphine causes corrosion of noble metals such as copper, silver, and gold, particularly at high humidity. Care is necessary to avoid damaging copper-containing electrical equipment and components during a fumigation. In recent years, as a result of incomplete insect control through inefficient fumigation practices in some countries, several insect species have become resistant to phosphine. Although this development has occurred outside the UK, resistant insects have been brought into the country on infested commodities. The magnitude of insect resistance has not yet attained an unmanageable level and resistant insects can be controlled by other methods such as by fumigation with methyl bromide.

12. Pure phosphine gas can not be delivered in pressurised containers because of the risk of explosion. However, experimental work on combining carbon dioxide with low concentrations of phosphine gas has proved both safe and commercially viable. While this delivery technique has yet to be registered for use in the UK, it has successfully been used in other countries. Should the technique gain UK registration, it will greatly improve phosphine fumigations.

Combinations employing phosphine

13. Developments in North America have lead to the proposal that a method combining low concentrations of phosphine and carbon dioxide plus heat, for a 36-hour treatment period should be considered as an alternative to methyl bromide fumigation for disinfesting flour mills. The corrosive action of phosphine has been of particular concern to those evaluating the method and also to potential users in the UK, because flour mills contain extensive electrical systems that could be at risk if phosphine were used as part of a combination treatment. The results of a recent investigation in North America have shown that corrosion by phosphine can take place even in the absence of high humidity. An additional potential constraint on the

combination method is the risk of insect resistance, that may result from exposing insects to low concentrations of phosphine for short periods. A flour mill in Hawaii has been treated on six occasions using the combination method, and recent survival of the flat grain beetle (*Cryptolestes* spp.) during such a treatment is suspected by the milling staff to due to insect resistance. However, this has yet to be substantiated in laboratory tests.

Hydrogen cyanide

14. This gas was formerly used as a commodity fumigant but was superseded by methyl bromide which is easier to use and probably more effective. Hydrogen cyanide is only registered for vertebrate pest control in the UK. In France, the gas continues to be used to fumigate aircraft because the exposure period to the gas is only 20 minutes (compared to two hours for methyl bromide) and planes are out of service for a very short period. Re-registration of hydrogen cyanide in the UK could be a major constraint to its re-introduction, and because it would only find minor uses, the cost for obtaining the data to enable registration would probably be too great.

Sulphuryl fluoride (Vikane)

15. This chemical has been used for many years in the USA, principally to control wood-destroying termites. Recently, however, its use in that country has been extended and it has now largely replaced methyl bromide for the control of other wood-damaging insects. Sulphuryl fluoride is less effective against the egg stage of insects and in consequence high dosages need to be employed which can lead to high chemical residues. For this reason the manufacturers have not sought to register use of the chemical for treating food commodities or premises or plant from which food commodities cannot be totally removed. The only country other than the USA in which sulphuryl fluoride is fully registered is Sweden, but other countries including Denmark may register it soon. The manufacturers of the chemical are reported to be keen to see the chemical more widely used as a replacement for methyl bromide for treating wood and wood products. Lack of registration in the UK is a major constraint to the introduction of sulphuryl fluoride, but it is reported that discussions with the pest control industry are to take place soon to determine the potential market and the case for registration. Sulphuryl fluoride is specifically excluded from use to fumigate aircraft because the manufacturer of the chemical considers the risk of litigation too great.

Other potential fumigants

16. Several other chemicals have been proposed as possible replacements for methyl bromide for certain uses, but none is registered in the UK. These include new chemicals such as carbonyl sulphide, cyanogen, ozone, methyl phosphine, and methyl isothiocyanate (already used as a soil nematicide), but none has progressed far beyond the experimental stage except for carbonyl sulphide, for which registration to treat timber is reported to have been applied for in Australia. Ethyl formate was previously used to treat grain but in recent years its use has been only for dried vine fruits and cereal products in some countries. Registration for use of the chemical as grain fumigant is being sought in Australia. Carbon bisulphide was formerly used as a

liquid fumigant for grain, sometimes as part of a mixture, but it fell into disuse some years ago and its registration has lapsed in most countries including the UK.

Controlled atmospheres including carbon dioxide

17. Atmospheres in which the concentration of oxygen is brought to below 1% using nitrogen or exhaust burner gases are effective for controlling insect pests. Long exposure periods are necessary, these being several weeks depending on the temperature, and very high levels of gas-tightness are required. Carbon dioxide is weakly insecticidal and similar conditions of gas-tightness and long exposure to those when using nitrogen apply. Carbon dioxide has been used commercially for treating bag stacks in Indonesia and in grain elevators in Canada. The long periods required when using controlled atmospheres and carbon dioxide may be reduced when combined with other factors such as high temperature or high pressure. However, carbon dioxide can cause serious corrosion of concrete structures such as grain silos.

Contact insecticides

18. Contact insecticides, including organophosphorus and synthetic pyrethroid compounds, are applied directly to some commodities such as unprocessed grains, and as surface sprays to storage building and transport vehicles. These chemicals are often used prophylactically because, unlike fumigants, they have persistent action. Contact insecticides cannot be considered direct replacements for methyl bromide but their use may reduce the frequency of or possibly avoid the need for fumigation.

Heat and cold

19. The application of heat, either alone, or as part of a treatment technique has received considerable attention in recent years as a potential replacement for methyl bromide fumigation. Heat applied to commodities or to buildings has been evaluated in several countries on a commercial scale and data on the cost for this are now available. Some commodities are particularly heat sensitive and for these, heat may not be an optional treatment method. Heat as part of a system, such as in conjunction with the use of controlled atmospheres, is to be evaluated in a research programme commencing in the UK during 1999. The chief advantage of heat either alone or in combination is that treatments can be relatively rapid approaching in some cases those achieved with methyl bromide.

20. To kill insects using cold treatment requires commodity temperatures to be brought to a very low level (-15°C), and for large bulks of grain this would be very costly. With small objects, such as museum specimens, the technique is effective and freezing can be used as an alternative to fumigation with methyl bromide.

Inert dusts

21. Improved formulations of inert dusts which may include diatomaceous earths or silica aerogels are finding increased use for treating grain and legumes to control insect pests. The dusts act to dehydrate insects and are particularly useful in dry conditions where application can cause insects to die from water loss. Application to store surfaces as a slurry has also proved effective for persistent insect control. Inert

dusts are now being considered for inclusion as part of an integrated control programme for stored products pests in some countries.

Integrated Pest Management (IPM)

22. Many of the components of IPM programmes, such as cleaning and inspection, have been practised by store managers for many years. Recent emphasis has been to intensify measures that are likely to reduce the need for frequent fumigation. These include the removal of insect harbourages, and more thorough cleaning programmes that remove commodity residues from plant and processing machinery. Monitoring devices such as insect pheromone traps are major parts of IPM systems. In developing such systems consideration is given to both chemical and non-chemical control measures and requirements may vary according to the situation. The principal aim of an IPM system is to move away from total reliance on a single pest control method such as methyl bromide fumigation. However, even when IPM systems are operated effectively the need for a full site disinfestation, such as by fumigation with methyl bromide, may be necessary occasionally. Some IPM systems may be operated on a wider basis than within a warehouse and processing complex or, at a flour mill. They may involve the sourcing of commodities from particular suppliers in the UK, or overseas, and include measures to ensure that infestation does not arise at any time during transportation.

Irradiation

23. Irradiation has a broad spectrum of activity against insect pests of stored products but a distinct disadvantage is that adult insects, though sterile, may not be rapidly killed by the treatment. Although there is increasing use of irradiation to treat food products world-wide, the food industry in many countries, including the in UK, is very concerned about consumer acceptance of irradiated food products. The siting of irradiation plants is a very sensitive issue in most countries and, in addition to the large capital investment of constructing such plants, there are unknown problems regarding the logistics and costs of moving commodities to and from the treatment plant.

Biological control methods

24. Biological agents are generally host-specific and are usually considered to provide a preventative rather than a curative treatment which is the major use for fumigation. They cannot, therefore, be considered as direct replacements for methyl bromide except possibly in certain special situations such as flour mills, where only a small number of pest species commonly occur. Biological control methods have been shown to give long term control in some warehouse situations.

Methodological Approach and Research Limitations

25. This section summarises the methods that NRI used to conduct this research. It also highlights the limitations of the study.

The research methodology was dictated by the availability of time. NRI followed a pragmatic approach that relied on telephone interviewing and faxed questionnaires (the questionnaire and an aide-memoire for telephone interviews are in Appendix 3). There was no opportunity to conduct extensive field visits. However, NRI staff visited key industry contacts that were within easy travelling distance.

26. NRI also had to concentrate on the industries that would be most seriously affected by the phase-out of methyl bromide. No attempt was made to quantify the impacts on industries that would be minimally affected.

27. On the issue of exemptions, the analysis was conducted on the assumption that none would be granted. This approach allows the evidence to support or counter cases for exemptions.

28. While many industry contacts were willing to release commercially sensitive information to the NRI research team, other contacts refused. This difficulty forced the research team to make more estimates and assumptions than would otherwise have been necessary. Other assumptions became necessary because industry contacts were either not fully aware of the consequences of the methyl bromide phaseout schedules or, were uncertain what the best courses of action should be.

Table 2. Categories and numbers of informants contacted during the course of this study

Category	Number
Fumigation companies	21
Commodity importers	20
Trade associations	9
Flour millers	4
Non-flour millers	5
Food Processors	3
Port health authorities	4
Others*	14
Total	**80**

* UK government departments, overseas government departments and specialist companies.

5. Quantities of Methyl Bromide Used in Structural and Commodity Fumigations

During the course of this study, NRI circulated a questionnaire to all the company members of the British Pest Control Association (BPCA) who are licensed to conduct methyl bromide fumigations. According to the BPCA, only these companies conduct methyl bromide fumigations in the UK. Each company was asked to report their methyl bromide usage according to the categories given in column one of Table 3. The figures in column two summarise the results of the questionnaire.

Table 3. Quantities of Methyl Bromide by Use Category in 1997

Category	Methyl bromide (tonnes)
Flour mills	76.4
Other buildings	18.2
Containers for export	35.2
Imported containers	16.0
Commodities in stacks	32.1
Imported timber	0.8
Whole ship	1.4
Aircraft	0.7
Other/unspecified	19.5
Total	**200.3**

29. According to BPCA figures from 1997, 206 tonnes of methyl bromide were used for non-soil and non-feedstock purposes. This total includes the BPCA use category "other – non stated". After discussions with the methyl bromide supply industry, NRI estimates that the quantity used under this category was 23 tonnes. The range for the true quantity of methyl bromide used for structures and commodities is therefore 183 to 206 tonnes. Given that all the major fumigation service companies and many of the smaller companies responded to NRI's questionnaire[1], we believe that 200 tonnes (Table 3) is close to the total UK structural and commodity usage in 1997.

30. The "other buildings" category in Table 3 includes fumigations of mills other than flour mills, food processing factories and warehouses.

31. The use category "Containers for export" includes fumigations (pre-shipment treatments) that are officially required by Australian and New Zealand regulations for goods that contain or are packed in infestible wooden materials. NRI estimates that approximately 70% of the methyl bromide in this category is used for this purpose. The rest is used for exports of used clothes, rice, perfumery, chemicals, motor parts, tyres and personal effects. The major destinations of these other containers are Africa, USA, Eastern Europe and Singapore. Used clothes sent to Africa account for most of the usage.

32. The majority of methyl bromide in the "Imported containers" category is used to fumigate commodities, of which cocoa, rice, dried fruit and nuts form the greatest share. Fumigations are usually conducted at docksides.

33. "Commodities in stacks" are fumigated in warehouses under gas-tight sheets. The major commodities treated in this category are cocoa, rice, coffee, dried fruit and

[1] Twenty one out of the thirty companies registered by the BPCA responded to the questionnaire.

nuts. "Imported timber" fumigations are conducted under the orders of the Forestry Commission to prevent the introduction of forestry pests. "Whole ship" fumigations are rare and are designed to destroy rats and cockroaches. "Aircraft" fumigations are conducted to destroy rats. "Other" uses include fumigations conducted in bubbles and chambers.

2. Control Scenarios and Issues for the Public Sector

Control scenarios.

34. This section examines the general implications of the three methyl bromide control scenarios that DETR/MAFF asked NRI to investigate (refer to Table 1 in the Introduction). Details of how each significant user will be affected by the control scenarios are contained in later sections of this report.

35. Restrictions will apply to methyl bromide production and supply, and not to individual users. In the UK's case, where no methyl bromide is manufactured, restrictions will be placed on the quantity of methyl bromide that supply companies are permitted to release onto the market.

36. The impacts of control scenario A are reasonably easy to predict. No methyl bromide would be available to users who would not be eligible for exemptions. From the beginning of 2001, these industries would be forced to use alternatives. Companies would start planning changes to their practices as soon as changes to the EU directive are announced.

37. The impacts of control scenario B are much more difficult to predict. Restrictions on the supply of methyl bromide would create a sellers' market, in which prices would inevitably rise. In addition, methyl bromide fumigation services would become more expensive as service providers become scarcer. For the purposes of this report, NRI has made the assumption that structural and commodity users can afford to pay substantially more for methyl bromide fumigations without significantly increasing total costs. These users would be able to outbid horticultural users, who are in a less advantageous position, and secure sufficient methyl bromide.

38. Scenario C differs from scenario B only by degree. Methyl bromide would be scarcer after 2001. However, given that exemptions would be made for pre-shipment and quarantine uses, and providing that before 2001, structural and commodity users make reasonable progress towards reducing their reliance on methyl bromide, there is reason to assume that sufficient methyl bromide would be available for structural and commodity fumigations.

The role of Public Authorities in Controlling Methyl Bromide

39. This section looks at current controls on the use of methyl bromide and then examines some of the issues that public authorities will face once restrictions on the supply of methyl bromide have been introduced.

Current control arrangements

40. To a large extent, the methyl bromide supply and fumigation industries regulate themselves. Supply companies ensure that all their customers are licensed to use methyl bromide by the British Pest Control Association (BPCA). Inspections are also made to ensure that methyl bromide is handled and stored properly at fumigators' premises.

41. The only external monitoring comes from the Health and Safety Executive (HSE), who make occasional inspections to ensure that methyl bromide is used safely and only for the purposes for which it is registered.

The impact of the methyl bromide phaseout

42. Under control scenario A, most methyl bromide supplies will cease at the beginning of 2001. Methyl bromide will only be available for critical uses and emergencies. Enforcement should not be difficult, because supplies to the UK are controlled by just two companies. Moreover, these companies should have little difficulty selling their stocks to fumigation companies before methyl bromide is phased out. There appears to be no barrier to fumigation companies using their stocks after phase-out.

43. The prolonged phaseout schedules proposed within control scenarios B and C would only add marginally to the difficulties of enforcing restrictions. Large quantities of methyl bromide would still be available on the market but if supplies to the UK remain in the control of a few responsible suppliers, the task of ensuring that legislated supply levels are not exceeded should be easy.

44. As yet there is no agreement on which public authority would monitor supplies of methyl bromide to the market. Staff within HSE believe that a change of government policy would be required before they could undertake a policing role. Their safety and permitted use inspections would continue as before.

45. Apart from monitoring supplies to the market, there would also be costs involved with assessing, granting and policing critical use and emergency exemptions.

3. Commodity Fumigations

Introduction

Table 4 presents estimates of the total quantity of methyl bromide that was used for imported commodity fumigations in 1997.

Table 4. Quantities of Methyl Bromide used in Commodity fumigation, 1997.

Category	Methyl bromide (tonnes)
Commodities in containers	14
Commodities in stacks	32
Total	**46**

45. The main commodities fumigated with methyl bromide are rice, cocoa, dried fruit, nuts and coffee. These commodities account for over 90% of the total commodity usage.

46. This part of the report examines current commodity fumigation practices and how these might change once methyl bromide has been withdrawn. It also considers the impacts on individual commodities. Greatest attention is paid to the five major commodities listed above.

Commodity Fumigations under Current Practices

47. Most fumigations practices are common to the major commodities that regularly require disinfestation. This section examines current commodity fumigation practices.

48. All commodities that regularly require re-fumigation in the UK are fumigated in the country of origin before export. The usual fumigants are phosphine and methyl bromide. Both chemicals can be highly effective in tropical climates, yet in practice, technical standards of fumigation in developing countries are often very poor. In addition, careless management and handling practices in warehouses greatly enhance the possibility of cross-infestation from a one-commodity stack to another.

49. On arrival in the UK, a large proportion of imports is taken directly to third party warehouses, where the containers are "destuffed" and the commodity bags placed in stacks. In most instances, warehouse managers decide which stacks require fumigation and then contact specialist firms to conduct the necessary work. Fumigation involves placing plastic sheets over the stacks, introducing the fumigant, periodically monitoring gas concentration levels and, when the appropriate fumigation period has elapsed, venting the stack. Methyl bromide fumigation periods depend on temperature, and fall within the range of 24 to 48 hours. The fumigator establishes safety zones of ten to fifteen metres around the stack. No unauthorised personnel are allowed to enter these zones.

50. Stacks are usually fumigated over the weekend, when warehouse activity is minimal. However, sheeting and venting activities may overlap with the working week.

51. Some commodity imports, especially rice, are regularly fumigated in containers on arrival at UK ports. Port health authorities are usually entrusted to decide which containers require fumigation. However, such fumigations do not come under UK quarantine regulations and the decision to fumigate is based on commercial and UK food legislation criteria. As far as possible, containers are fumigated in isolated yards, where the risk to port employees is minimal. Apart from sheeting, the fumigation operations are the same as those for stack fumigations conducted in warehouses.

52. Port authorities allow importers a period of grace before charging for ground slots that are required for fumigation. Depending on the port, the periods can extend from three to seven days, after which heavy incremental charges are levied. The charges are designed to encourage importers to move their commodities quickly away from UK ports, most of which are already congested.

53. A proportion of rice imports is fumigated in barges, ships and silos. Methyl bromide is generally used in ships and barges, while phosphine tends to be used in silos, where a rapid movement of stock is not generally required.

Options for commodity importers after the phaseout of methyl bromide

54. In general, the technical and non-technical options for commodity importers who will be significantly affected by the methyl bromide phaseout are similar. This section summarises the implications of these options.

Phosphine

55. Metal phosphide formulations generating phosphine are the only alternative fumigants to methyl bromide currently registered for commodity re-fumigation in the UK. Contrary to some views expressed by UK industry, there is no reason why phosphine can not be as effective as methyl bromide, even in the midst of UK winters. However, in some cases, the incremental costs of switching from methyl bromide to phosphine will be considerable. The largest cost increases will arise because phosphine fumigations require longer periods to be effective. In summer, phosphine fumigation takes between five and six days, while in winter, the figure rises to between ten and twelve days. Methyl bromide fumigations, on the other hand, take between 24 and 48 hours depending on the temperature. The time taken for sheeting and venting is generally the same whether the fumigation is with phosphine or with methyl bromide.

56. The impact of increased fumigation periods will be felt in several ways. Firstly, if the same volume of commodities is fumigated in UK ports and warehouses as currently is practised, the problem of congestion will probably be paramount. In particular, the UK's ports will not be able to accommodate containers will have to occupy ground slots for up to six times longer. For the reduced number of ground

slots that will be available, the importer will have to pay ground slot charges of between £50 and £80 per container per day, once grace periods have expired. Such charges are very expensive compared with warehouse charges. In addition, port authorities may be tempted to increase ground slot charges to ensure that port congestion remains manageable.

57. Increased fumigation times will also create congestion in warehouses. A proportion of the commodities that will previously have been fumigated on docksides, will require warehouse space for fumigation with phosphine. Perhaps more importantly, longer fumigations will reduce the turnover of commodities currently stored and fumigated in warehouses, and lead to additional congestion. The need to maintain safety zones around stack fumigations for longer periods will further decrease the space available for storing commodities.

58. Logistical problems will arise because a greater number of stacks would be under fumigation at any one time. The positioning of fumigation stacks will become critical because careless placement will create inaccessible spaces within warehouses.

59. While there is currently very little excess capacity in the warehousing sector, acquiring new space is not difficult. However, short leases on warehouse property are generally not available and therefore warehouse operators would have to be convinced that the new capacity would be required for several years ahead. Where extra capacity is introduced, warehouse operators might be tempted to increase warehousing charges to cover themselves against the risk of reduced demand for warehouse space in the future.

60. The availability of sufficient warehouse space (particularly under control scenario A) is therefore uncertain. The answer will ultimately depend not only on capacity decisions made by warehouse operators but also on how successfully commodity importers can reduce the frequency of UK re-fumigations (refer to sections 3.2 and 3.3).

61. Another impact of increased fumigation times will be on working capital. Without exception, all the commodities that will be significantly affected by the methyl bromide phaseout are high value. In cases where normal UK stockholding is insufficient to absorb longer fumigation periods, the working capital cost of holding increased stocks will be high.

62. As well as costs associated with longer fumigations, there may also be an increase in the charges which service companies make for fumigation. The cost of phosphine fumigation will be at least similar to or possibly twice as expensive as methyl bromide fumigation. Magnesium phosphide, the most suitable phosphine releasing chemical for UK winter conditions, is approximately four times the price of methyl bromide per treatment[2]. Aluminium phosphide, the much cheaper alternative which is popular in the tropics, may be the most appropriate option in warmer months. Given the longer fumigation periods, the number of times fumigators have to inspect fumigations increases. Fumigation charges will increase accordingly.

[2] However, the cost of methyl bromide is increasing in anticipation of its phaseout.

Improving fumigation at origin

63. All the commodities that will be significantly affected by the methyl bromide phaseout are fumigated at origin prior to export to the UK. In many cases, poor fumigation standards and careless pre-shipment handling create the need for re-fumigation on arrival in the UK. There is no reason why fumigation at origin can not be greatly improved. Over recent years, a few UK commodity importers have reaped considerable rewards from insisting upon and teaching better practices at origin. However, such initiatives have been the exception and have been led by far-sighted individuals. Other commodity importers have been slower to react because re-fumigation in the UK is quick, easy, and has not added significantly to procurement costs.

64. For many years, large commodity importers have been in ideal positions to improve pest control and fumigation at origin. Seen in this light, the introduction of controls on methyl bromide will benefit both industry and the environment by ending wasteful re-fumigation practices in the UK. Improving practices at origin requires considerable initial commitment. However, compared with phosphine re-fumigation in the UK, this option will doubtless appear very attractive to commodity importers when methyl bromide is phased-out.

65. UK companies that have improved pest control and fumigation in exporting countries have achieved success by regular personal contact with sellers in these countries, and by providing guidelines and training to exporter employees. In some instances, the supply chain from producer to embarkation has been examined and causes of infestation have been removed. UK personnel have tried to convince sellers that re-fumigation in the UK is neither in the interest of the seller, who in some instances has to pay for re-fumigation in the UK, nor in the interest of the buyer, who has to cover working capital and administrative costs.

66. The cost of improving pest control and fumigation at origin is difficult to gauge. Senior UK staff members are usually involved, and therefore staff costs can be high. Other expenses such as airfares and accommodation must also be found. Annual bills of over £50,000 may be common for firms actively engaged in such activities.

67. Although such costs are probably easily absorbed by the large importers commonly involved in the cocoa, coffee and rice trades, smaller importers may have greater difficulty. Moreover, large companies have an added advantage. Their market power is often sufficient to ensure that their wishes are followed at origin. Smaller companies, who often deal with a more diverse set of suppliers, are in a weaker position. Such companies can be found in the dried fruit, nut, herbs and spices sectors.

68. A sensible approach to improving pest control at origin would involve co-operation within commodity sectors. Concerted sectoral action could reduce costs to individual importers, reduce the time before significant results are achieved, and help promote long term sustainability. However, thus far, companies that have achieved

success at origin have found individual action easier than seeking co-operation within their industry. Confidentiality, suspicion and the desire to benefit as free-rider have no doubt played a negative role. In the future, the costs and difficulties of UK re-fumigations after the phaseout of methyl bromide, may help to focus industry minds on the benefits of co-operation.

69. Another important aspect of pest control and fumigation at origin, is the question of how quickly results can be achieved. There is sufficient anecdotal evidence to believe that dramatic progress can be made within the space of one year or less. However, a sustained effort over several years is required to ensure that good practices are maintained. In practice, the inertia that has long prevented UK industry from making improvements at origin may continue to retard progress until incremental costs start to mount.

Commodity inspections in the UK

70. More commodity fumigations are conducted in the UK than are strictly necessary. The ease and low cost of methyl bromide fumigations has encouraged some companies to adopt blanket fumigation policies, thereby reducing the possibility of accidental infestation of manufacturing plants. Warehouse managers have also liberally called on the services of commodity fumigators to avoid accidental infestation of warehouses.

71. Two major UK commodity importers have managed to reduce the frequency of their re-fumigations by employing independent inspectors to check each consignment soon after arrival in the UK. The inspectors decide if fumigation is necessary. In cases where the seller can be charged UK re-fumigation costs, the inspection system has the added advantage that the blame for infestation can be easily attributed.

Cocoa

Cocoa industry structure, imports and fumigations

72. The UK cocoa industry is dominated by five large companies, and of these, the largest two account for approximately two thirds of total UK cocoa bean imports. Over 80% of UK cocoa comes from West Africa, notably from Ghana, Nigeria and Cote d'Ivoire. All West African cocoa is fumigated at source. Fumigation and pest control standards are generally very poor.

73. An average of approximately 180,000 tonnes of cocoa beans is imported to the UK each year. Most cocoa arrives in the UK packed in natural fibre bags which have been loaded into containers. However, a small but growing proportion of cocoa is imported in bulk. While countries such as Germany extensively use bulk handling techniques, the UK has only limited cocoa bulk handling capacity, and consequently, only about 10% to 15% of imports are handled in this way. The advantages of bulk compared with container techniques are reduced handling and bagging costs. There may also be an advantage in that the jute bags, in which most containerised cocoa is stored, harbour pests and their eggs. Dispensing with these sacks probably reduces

the potential for infestation, yet there is no unanimity within the industry either on this issue or on whether bulk handling as a whole is an appropriate way of handling cocoa.

74. The first shipment of cocoa usually arrives in the UK in January, and the last arrives in either July or August. Cocoa buyers therefore have to ensure that by the time the last shipment has arrived, they are carrying sufficient stocks to ensure factories can be supplied until the first shipment of the following season. The costs of storing cocoa in the UK are significant, and include warehousing costs, the cost of working capital tied up in stocks, and insurance.

75. Contractual arrangements for trading cocoa come under Cocoa Association of London (CAL) terms, or under the Association Francaise du Commerce du Cacao (AFCC) terms, or at least in one case, under specific terms dictated by the buyer. Contract terms have relevance for fumigation because CAL rules state that, if re-fumigation of cocoa is necessary in the UK, and there is evidence that the seller is at fault, then the costs of re-fumigation are charged to the seller. By contrast, AFCC rules accept fumigation certificates issued at origin by international inspection companies such as Societe Generale de Surveillance (SGS), as evidence that the seller is not at fault. The unanimous opinion within the UK cocoa industry is that such certificates have little value. However, proving seller responsibility under CAL rules is not easy, and consequently much time is wasted in negotiations. CAL and the industry are currently investigating ways of reducing this problem.

76. Overall, approximately 65% (120,000 tonnes) of cocoa bean imports is re-fumigated in the UK. Methyl bromide is the only fumigant used. Most cocoa bean imports are fumigated in third party warehouses, though a small proportion is fumigated in containers on the dockside.

Methyl bromide phaseout

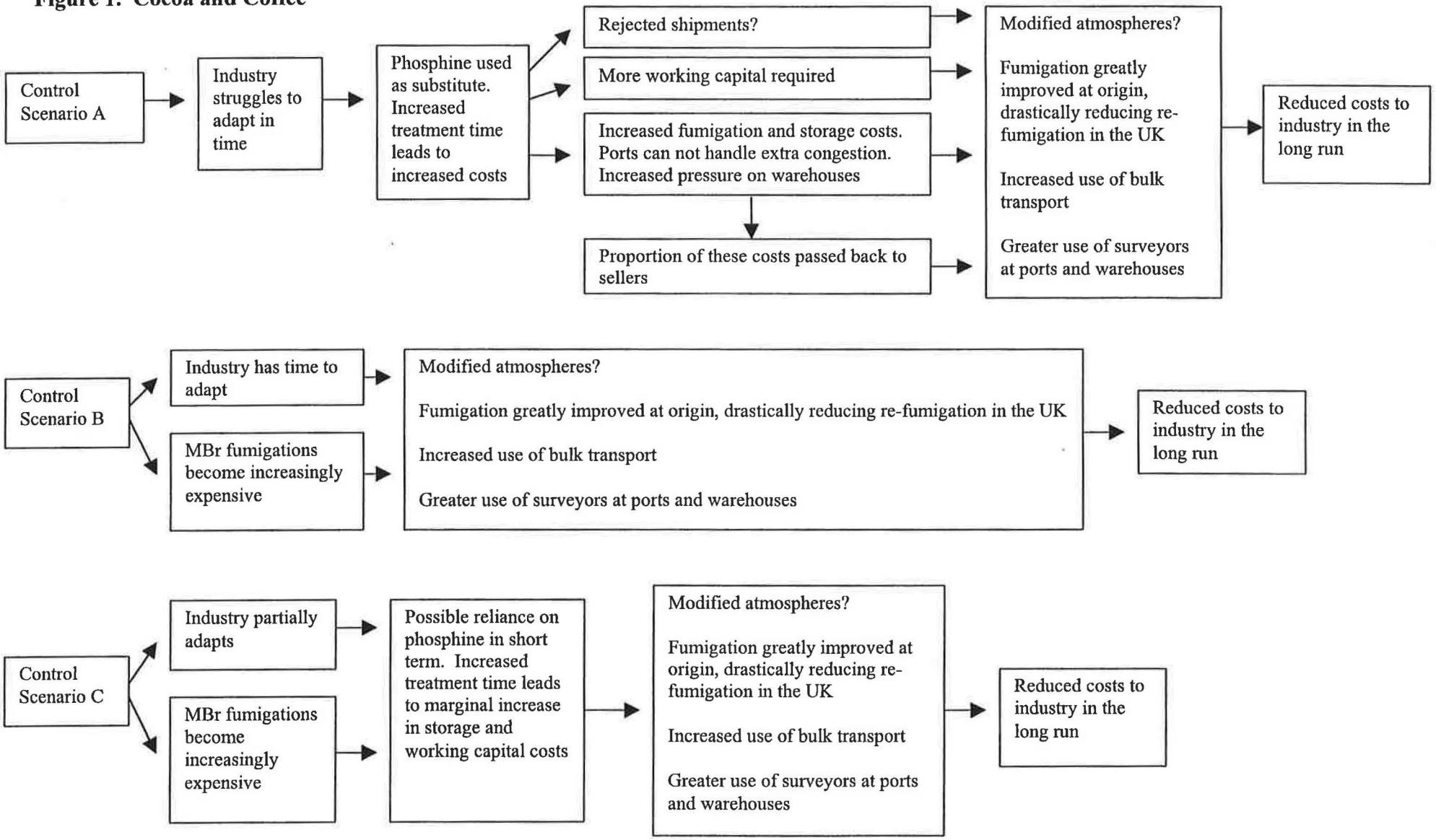
77. The potential impacts on the UK cocoa industry of the methyl bromide phaseout are presented in Figure 1. Each control scenario is considered separately. The flow diagrams represent what NRI believes are the most likely outcomes from each scenario.

Control Scenario A:

Under this scenario, the assumptions in Appendix 1 have been used. In the short term, the industry would be forced to rely heavily on phosphine. This would lead to:

- An increased likelihood that importers will reject heavily infested shipments. The costs of doing this are high and would act as a great incentive for both buyers and sellers to ensure that fumigation and pest control is conducted properly at source.

Figure 1. Cocoa and Coffee



- A greater amount of working capital tied up in stocks. Extra stock would have to be held for six months of the year. This would ensure that sufficient cocoa is available until the first shipments of the new season can be fumigated with phosphine and supplied to the factories[3]. At other times of the year, normal stock levels would be sufficient to absorb the increased fumigation time.

- Increased storage and insurance costs. The extra stock would have to be stored in warehouses and insured.

- Increased costs of fumigation. NRI estimates that the cost of phosphine fumigations would be one and a half times current cost of methyl bromide fumigation.

78. The incremental costs described above would encourage the industry quickly to improve practices at origin and to increase the number of independent commodity inspections in the UK. Sellers would also have a large financial incentive to improve pest control and fumigation at origin.

79. For those occasions when UK re-fumigations still prove necessary, alternative disinfestation techniques may become available, possibly through the LINK heat and modified atmosphere project for commodities. However, predicting the efficacy and cost effectiveness of such alternatives is not currently possible.

80. There may also be greater use of cocoa bulk handling techniques, thereby further reducing infestation problems. However, as previously noted, there is no consensus within the industry on the appropriateness of these techniques.

81. The figures in Table 5 are merely intended to give an indication of compliance costs, and are not precise quantifications. As such, Table 5 summarises the estimated incremental costs that the UK cocoa industry would bear in the first year after the restrictions under scenario A take effect. All costs that would not change have been ignored. Costs in subsequent years are assumed to be substantially lower because the industry would react by putting greater effort into improving practices at origin. Ultimately, very low levels of UK re-fumigation are achievable, and therefore annual compliance costs would eventually be close to zero.

[3] Not all of the first shipments would have to be re-fumigated in the UK. However, the first shipments generally arrive from Ivory Coast where fumigation standards are amongst the poorest.

Table 5. Incremental Costs to the UK Cocoa Industry in the First Year After the Introduction of Control Scenario A.

Incremental Cost Category	Incremental cost **Low Estimate (£)**	Incremental cost **High Estimate (£)**
Working Capital	192,000	288,000
Insurance	4,000	7,000
Storage	28,000	43,000
Fumigation	18,000	55,000
Total	**242,000**	**393,000**

Note that the figures relate to incremental costs according to the assumptions given in Appendix 1. Accordingly, the low and high estimates were calculated by using different assumptions about how quickly the industry would decrease the frequency of re-fumigations in the UK.

82. The incremental costs for the low estimate amount to approximately 0.1% of the annual value of imports. The corresponding figure for the high estimate is approximately 0.17%.

83. The largest incremental cost in the first year would be the cost of working capital tied up in extra stock. As the need for UK re-fumigations decreases, the industry would decide to hold less stock, knowing that a smaller quantity of the first shipments would require re-fumigation.

84. The cost of improving fumigation and pest control at origin is difficult to predict. The final figure would depend on how much industry co-operation exists. Moreover, the UK would not be the only country with an interest in improving practices at origin. Pressure would also be applied from North American and other European countries. The costs would also have to be set against the long term prospect that the UK industry will be able to reduce the costs associated with re-fumigation. For these reasons, NRI is unable to estimate the cost of improving pest control and fumigation at origin.

Control scenario B:

85. As discussed previously (Part 2, section 1), the outcome of scenario B is difficult to predict. As a relatively minor user, there may be no need for the cocoa industry to alter its practices until 2005. However, the costs of methyl bromide fumigation might rise sufficiently after 2001 to make alternatives more attractive.

86. Control scenario B would allow sufficient time for the industry to adapt. Incremental costs would arise through improving pest control and fumigation at origin, through increased methyl bromide fumigation charges, and through using phosphine or modified atmospheres for occasional re-fumigations in the UK after 2005. However, as noted elsewhere, the industry would have saved money by having reduced the need to re-fumigate in the UK.

87. Under the circumstances described above, cocoa industry compliance costs under scenario B would be minimal compared with the costs under scenario A.

Control scenario C

88. Scenario C would be similar to scenario B. After 2001, the cocoa industry would be able to use methyl bromide during the crucial period at the beginning of the cocoa shipping season. This would eliminate the need to hold extra cocoa stocks as discussed previously in this section. Incremental storage, working capital and insurance costs would therefore be zero.

Coffee

Coffee industry structure, imports and fumigation

89. The UK annually imports between 100,000tonnes and 120,000tonnes of green coffee. The major suppliers are listed in Table 6.

Table 6. Percentage distribution of green bean imports by main countries of origin

Countries of origin	1994	1995	1996	1997
Vietnam	2,6	7,7	11,5	20,7
Colombia	17,7	11,7	14,1	11,5
Indonesia	18,0	17,4	19,8	10,2
Costa Rica	16,7	20,0	12,9	7,4
Brazil	10,0	11,2	5,2	6,2
Kenya	6,7	5,8	6,1	5,7
El Salvador	0,3	0,4	3,4	5,4
Uganda	8,6	3,1	8,5	5,3
Cameroon	0,2	0,6	0,3	4,7
Honduras	1,0	1,8	2,5	3,8

Source: European Coffee Report 1997, May 1998 by ECF-European Coffee Federation

90. The UK coffee industry is dominated by two multinational companies, which import approximately 95% of the UK's green coffee. UK coffee consumption is stable and the overwhelming preference is for soluble coffee. Roast and ground coffee accounts for less than 8% of the market.

91. Fumigation with either methyl bromide or phosphine is conducted at origin before shipment. Standards of fumigation and pest control vary between countries of origin. The situation is worse in East and West Africa than in South East Asia and Latin America. Compared with cocoa, coffee is inherently "cleaner" and therefore less prone to infestation. Technical standards of coffee fumigation at origin are also generally better than standards for cocoa.

92. All green coffee imported to the UK is containerised. Imports arrive regularly throughout the year and consequently only a small amount of stockholding occurs. A small proportion of infested coffee is fumigated in ports, while the rest is taken to third party warehouses for fumigation. Methyl bromide is the only fumigant currently used. Approximately 10% of UK coffee imports are re-fumigated in the UK. As with

cocoa, UK coffee buyers are often able to pass UK re-fumigation costs back to the seller.

93. The industry has already made significant progress towards eliminating the need for UK re-fumigations. This has been achieved by improving pest control at origin and inspection of coffee at UK ports to avoid unnecessary fumigations.

The impacts of the methyl bromide phaseout

94. The potential impacts on the UK coffee industry of the methyl bromide phaseout are the same in nature as the impacts on the cocoa industry. Figure 1, therefore, refers to the impacts on both industries. However, while the types of impacts are similar, the financial effects would be different.

Control Scenario A

95. Under this scenario, the assumptions in Appendix 1 have been used. In the short term the industry would be forced to rely heavily on phosphine fumigations. This would lead to:

- An increased likelihood that importers would reject heavily infested shipments. The costs of doing this are high and would act as a great incentive for both buyers and sellers to ensure that fumigation and pest control is conducted properly at origin.

- A greater amount of working capital tied up in stocks.

- Increased storage and insurance costs. The extra stock would have to be stored in warehouses and insured.

- Increased fumigation costs. Phosphine fumigations in warehouses are more expensive than methyl bromide fumigations.

Table 7. Incremental Costs to the UK Coffee Industry in the First Year After the Introduction of Control Scenario A.

Incremental Cost Category	Incremental cost **Low Estimate (£)**	Incremental cost **High Estimate (£)**
Working Capital	16,000	48,000
Insurance	-	1,000
Storage	1,000	2,000
Fumigation	1,000	3,000
Total	**18,000**	**54,000**

96. The figures in Table 7. are intended only to give an indication of compliance costs, and are not precise quantifications. As such, Table 7 summarises estimated incremental costs that the UK coffee industry would bear in the first year after control scenario A is introduced. All costs that would not change have been ignored. Costs in subsequent years are assumed to be substantially lower because the industry would react by putting greater effort into improving practices at origin. Very low levels of UK re-fumigation are achievable, and therefore annual compliance costs would eventually be close to zero.

97. Note that the figures relate to incremental costs according to the assumptions given in Appendix 1. Accordingly, the low and high estimates were calculated using different assumptions about how quickly the industry would decrease the need for re-fumigations in the UK.

98. Both the high and low estimated incremental costs in Table 7 amount to approximately 0.02% of the value of annual imports.

99. The largest cost element would be the cost of working capital required to hold greater stocks of coffee. Incremental storage and fumigation costs would be relatively small. The burden of costs throughout the industry would be uneven because some parts of the industry have already dramatically reduced the frequency of their UK re-fumigations.

100. The cost of improving fumigation and pest control at origin is difficult to predict. The final figure would depend on how much industry co-operation exists. Moreover, the UK would not be the only country with an interest in improving practices at origin. Pressure would also be applied from North American and other European countries. For these reasons, NRI is unable to estimate the cost of improving pest control and fumigation at origin.

Control scenarios B and C

101. Under these scenarios, the coffee industry would experience similar impacts to those felt by the cocoa industry (refer to Section 4.2 for a discussion of the cocoa industry case). Sufficient methyl bromide would probably be available to allow the coffee industry to gradually decrease the number of re-fumigations in the UK. The compliance costs for the coffee industry under scenarios B and C would be minimal compared with control scenario A.

Rice

Rice Industry Structure, Imports and Fumigations

102. On average, the UK imports approximately 290,000 tonnes of rice per year. Five major importing and milling companies import rice for the UK uncooked rice market. In addition, two multinational companies import rice for inclusion in processed meals. NRI estimates that over three quarters of rice imports are destined for the uncooked market.

103. Rice arrives in the UK from numerous destinations. Table 8 summarises the percentage shares of the major countries of origin for 1995 to 1997.

Table 8. Percentage distribution of rice imports by main countries of origin

Countries of origin	**1995 %**	**1996 %**	**1997 %**
India	15	20	26
Italy	16	17	17
United States	17	11	14
Belgium & Lux	11	10	6
Australia	5	5	4
Spain	4	2	4
Guyana	1	0	3
Thailand	1	2	2
Pakistan	0	0	2

Source: Eurostat

104. Rice arrives in the UK continually throughout the year. Despite this, the nature of the industry is such that large stocks are held in the UK. Most stocks are held in silos but when insufficient capacity exists, rice is stored in third party warehouses.

105. All rice is fumigated in the country of production before arrival in the UK. Depending on practices in the country of origin, the fumigant is either phosphine or methyl bromide. Standards of fumigation vary considerably. Rice from the US only rarely requires re-fumigation in the UK, while Indian and Italian rice frequently require to be re-fumigated.

106. Rice is imported both in bulk and in containers. Infested bulk rice is sometimes fumigated with methyl bromide in ships and barges at the port of arrival. The short treatment times do not attract significant demurrage.

107. Infested rice that arrives in container is either re-fumigated at the dockside, in third party warehouses or in storage silos. Practices vary significantly between companies, each of which tries to minimise logistical, fumigation and storage costs.

108. A significant proportion of rice is fumigated in silos. In such cases, phosphine has proved an effective fumigant, especially where a quick turnover of stock is not required. However, phosphine fumigation in silos presents some technical difficulties. These can be summarised as follows:

- Long treatment times
- Phosphine's tendency to leak from non-gas-tight structures
- Most grain silos are not gas-tight
- Unlike methyl bromide, extra phosphine can not be readily introduced once fumigation has started. Methyl bromide is introduced as a gas, whereas phosphine is delivered in solid form.

109. Fumigators using phosphine, therefore, have to make silos as gas tight as possible and then estimate the rate of leakage. Initial dosage levels may have to be high to compensate for decreased gas concentrations as the fumigation progresses.

110. Parts of the industry have worked closely with their suppliers to improve fumigation practices at origin. Their success suggests that others should follow their example. However, unlike most of their counterparts in the cocoa and coffee industries, not all rice importing companies are sufficiently large to ensure that their wishes are followed at origin. The process of improving pest control at origin may therefore be very time consuming, at least for some companies.

112. NRI estimates that 45% of rice imports undergo re-fumigation with methyl bromide on arrival in the UK.

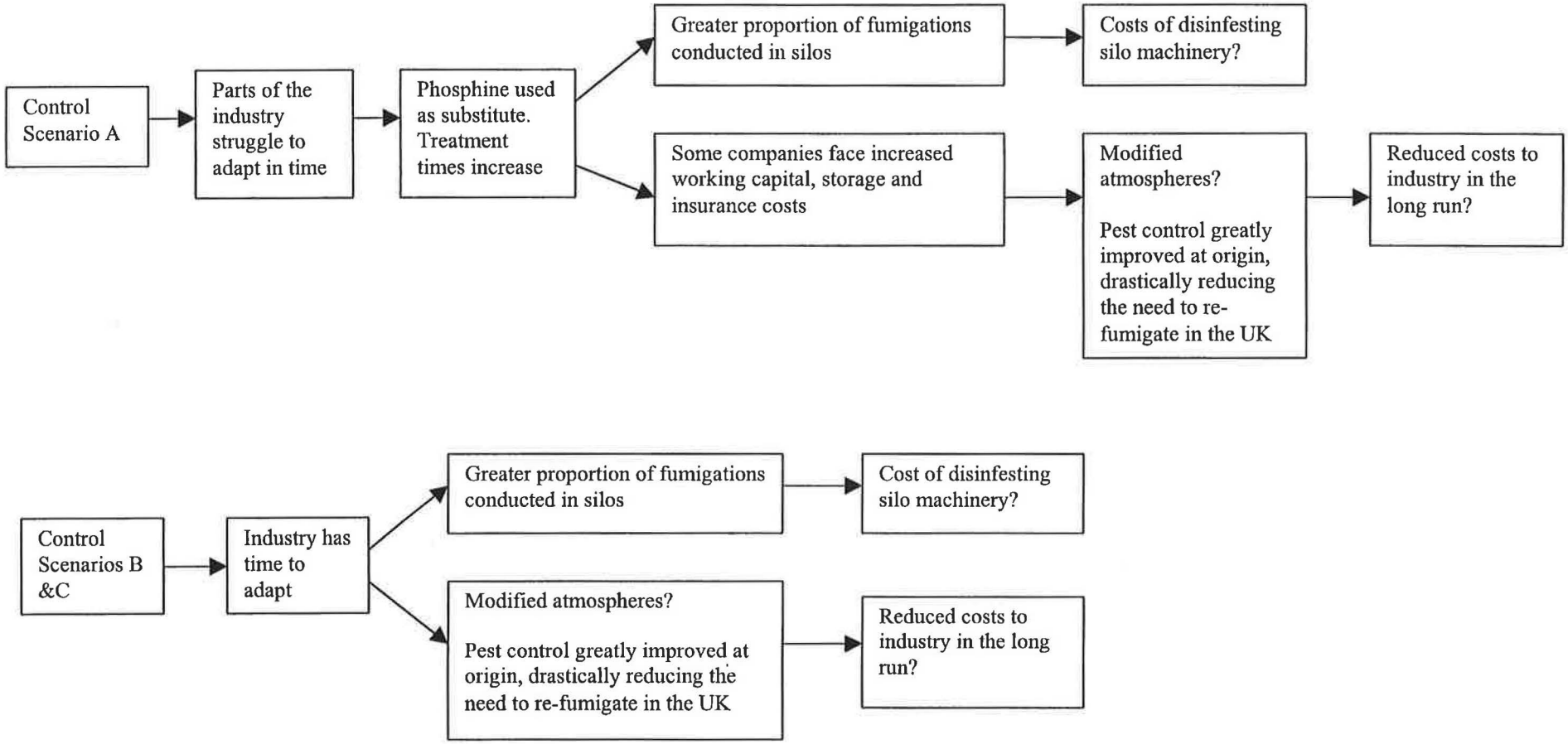
The Effects of the Methyl Bromide Phaseout

113. This section looks at the effects of methyl bromide phaseout on rice importation. The impacts on rice mills are considered in a later section.

114. The diversity of UK re-fumigation practices within the industry means that the impacts of the methyl bromide phaseout would be felt differently by each company in the industry. Some companies currently use either very little or no methyl bromide to control infestation problems. Others rely heavily on methyl bromide. The distribution of compliance costs throughout the industry would therefore be uneven.

115. The potential impacts of the phaseout are presented in Figure 2.

Figure 2. Rice



Control Scenario A

116. Under this scenario, the assumptions in Appendix 1 have been used. In the short term, the industry would be forced to rely on phosphine. This would lead to:

- More fumigations conducted in silos. Some companies have avoided placing infested rice in silos to avoid the risk of infesting silo machinery. Mechanical systems that move grain in and out of silos are difficult to disinfest. However, once fumigations in ships and in ports become financially unviable, fumigations in silos would have to be reconsidered.

- An increase in working capital costs for some of companies. Most of the industry already holds sufficiently large stocks of rice to absorb longer treatment times without having to hold much extra stock. However, some companies, especially those involved in food manufacturing, transport rice directly from ports to their factories, where the rice quickly enters the processing cycle. With increased fumigation times, such companies would be forced to hold greater stocks to ensure that sufficient rice is always available to the factories.

- Costs of diverting rice. Rice that quickly enters the processing cycle would have to be diverted to warehouses or other suitable storage facilities. This would involve incremental transport and handling costs.

- Increased storage and insurance costs, the increased stockholding would have to be stored, in warehouses.

117. For those occasions when UK re-fumigations still prove necessary, alternative disinfestation techniques may become available, possibly through the LINK modified atmospheres project for commodities. However, predicting the efficacy and cost effectiveness of such alternatives is not currently possible.

Table 9. Incremental Costs to the UK Rice Importing Industry in the First Year After the Introduction of Control Scenario A.

Incremental Cost Category	Incremental cost **Low Estimate (£)**	Incremental cost **High Estimate (£)**
Working Capital	36,000	48,000
Transport and handling	28,000	84,000
Insurance	1,000	1,000
Storage	42,000	56,000
Total	**107,000**	**189,000**

118. The figures in Table 9 are merely intended to give an indication of compliance costs, and are not precise quantifications. As such, Table 9 summarises the estimated incremental costs that the UK rice industry would bear in the first year after control scenario A is introduced. All costs which would not change have been ignored. Costs in subsequent years are assumed to be substantially lower because the industry would react by putting much greater effort into improving practices at origin. Very low

levels of UK re-fumigation are achievable, and therefore annual compliance costs would eventually be close to zero.

119. Note that the figures relate to incremental costs estimated using the assumptions given in Appendix 1. The low and high cost estimates were calculated using different assumptions about how quickly the industry would decrease the frequency of re-fumigations.

120. The incremental costs for the low estimate in Table 9 amount to approximately 0.08% of the annual value of imports. The corresponding figure for the high estimate is 0.14%.

121. Estimating changes in costs of fumigation was complicated by the high level of secrecy that is maintained in parts of the rice industry. Despite this, there is reason to believe that fumigation costs will decline if more fumigations are conducted in silos using phosphine. However, companies that opt for rice fumigations in silos will face incremental costs from disinfesting the mechanical feed systems of silos. The net cost is therefore assumed to be zero.

122. As with the other commodities, the cost of improving fumigation and pest control at origin is difficult to predict. However, these costs would be offset by the long term prospect that the UK industry would be able to reduce the costs associated with re-fumigation. For these reasons, NRI is unable to estimate the cost of improving pest control and fumigation at origin.

Control scenarios B and C

123. As discussed previously, the outcome of scenarios B and C is difficult to predict. As a relatively minor user, there may be no need for the rice industry to alter its practices until 2005. However, the costs of methyl bromide fumigation might rise sufficiently after 2001 to make alternatives more attractive.

124. Assuming that a will exists within the industry to pursue methyl bromide fumigation alternatives, control scenarios B and C would allow sufficient time for the industry to adapt. Incremental costs would arise through improving pest control and fumigation at origin, through increased methyl bromide fumigation charges, and through using phosphine or modified atmospheres for occasional re-fumigations in the UK after 2005. However, as noted elsewhere, the industry would be saving money by having reduced the need to re-fumigate in the UK.

125. Under the circumstances described above, rice industry compliance costs under scenarios B and C would be minimal compared with the costs under scenario A.

Dried Fruit

Dried fruit industry structure and fumigation practices.

126. The UK annually imports 150,000 to 200,000 tonnes of dried fruit. In order of importance, the major suppliers are Turkey, Greece and the US. Other suppliers

include South Africa, France, Italy, Australia, China and Iran. The main types of dried fruit are sultanas, currants, raisins, prunes, apricots, figs and dates.

127. The industry contains a mixture of large, medium and small-scale importers. Companies typically perform the roles of importer, final processor, packager and distributor.

128. Fumigation is conducted at origin before shipment. As with other fumigated commodities, standards of fumigation vary between countries of origin. Better standards are generally maintained in the US than at other origins.

129. All dried fruit imports are containerised. Imports arrive regularly through the year and only a small amount of stockholding occurs. Imports are either fumigated in containers on docksides or taken to warehouses for stack or chamber fumigations.

130. Approximately 55% of dried fruit imports are re-fumigated in the UK using methyl bromide.

The impacts of the methyl bromide phaseout

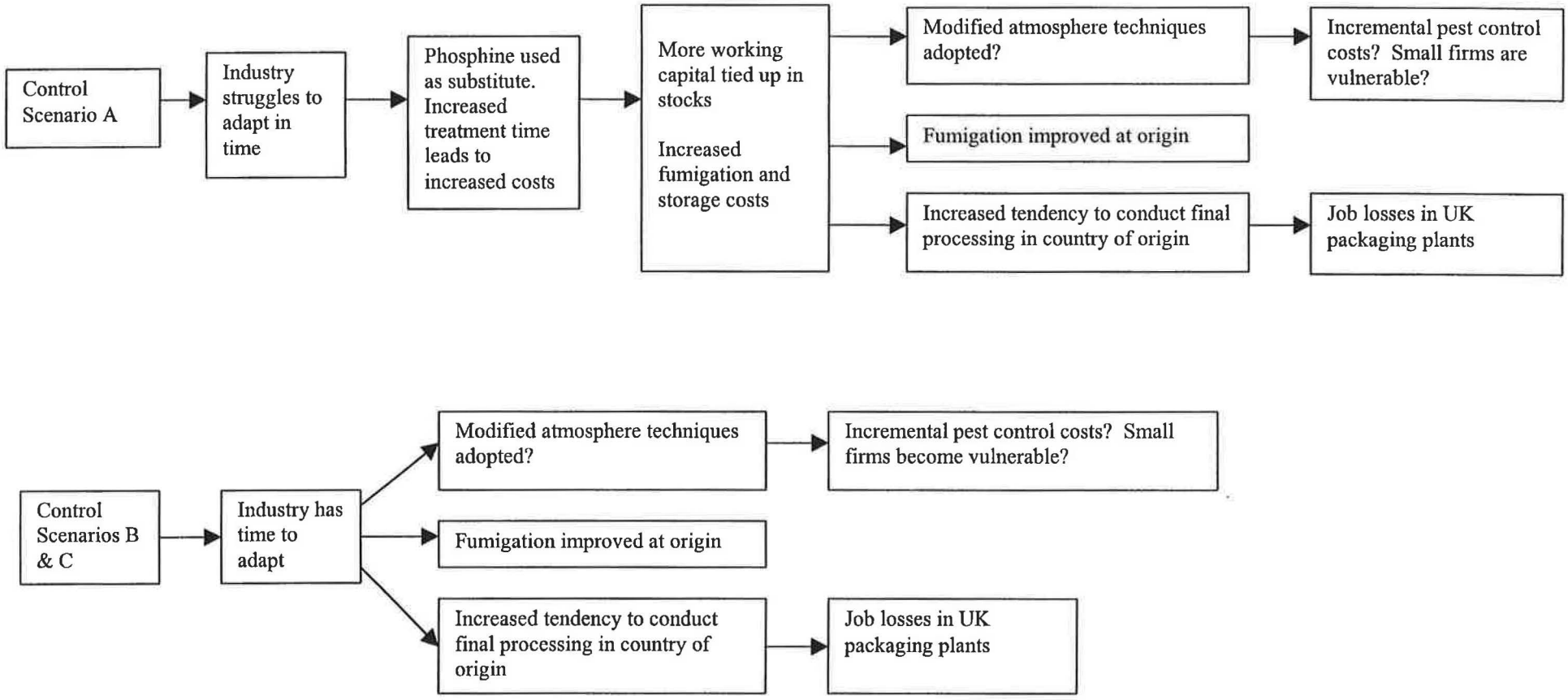
131. The potential impacts of the methyl bromide phaseout are presented in Figure 3.

Control Scenario A

132. Under this scenario, the assumptions in Appendix 1 have been used. In the short term, the industry would be forced to rely on phosphine. This would lead to:

- Increased working capital costs. The industry would need to hold greater stocks to accommodate longer fumigation times.

Figure 3. Dried Fruit and Nuts



- Increased storage costs. The greater stockholding would have to be stored. Imports previously fumigated in ports would have to be stored in third party warehouses. Storage of dried fruit is expensive because stacks must remain low to avoid spoilage.

- Increased transport and handling costs. Imports previously fumigated in ports would have to be redirected to third party warehouses.

133. Compared with other commodity importers, some dried fruit importers would find difficulty influencing fumigation and pest control practices at origin. Only the larger companies that have regular overseas suppliers would be able quickly to reduce the number of UK re-fumigations.

134. The incremental costs of fumigating dried fruit in the UK may encourage some companies to conduct processing and packaging in countries of origin. This would lead to job losses in UK packing plants.

135. Alternative disinfestation techniques may become available, possibly through the LINK heat and modified atmosphere project. However, predicting the efficacy and cost effectiveness of these alternatives is not possible.

136. Small firms in the dried fruit industries may become vulnerable to bankruptcy after the phaseout of methyl bromide. Increased disinfestation costs and an inability to improve pest control and fumigation at origin may have severe consequences for their financial viability.

137. The figures in Table 10 are merely intended to give indications of compliance costs, and are not precise quantifications. As such, Table 10 summarises the estimated incremental costs that the UK dried fruit industry would bear in the first year after control scenario A is introduced. Costs in subsequent years are assumed to be substantially lower because the industry would react by putting much greater effort into improving practices at origin. Low levels of UK re-fumigation are achievable, and therefore annual compliance costs would eventually be low.

Table 10. Incremental Costs to the UK Dried Fruit Importing Industry in the First Year After the Introduction of Control Scenario A.

Incremental Cost Category	Incremental cost **Low Estimate (£)**	Incremental cost **High Estimate (£)**
Working Capital	83,000	125,000
Transport and handling	2,000	3,000
Insurance	2,000	3,000
Storage	144,000	216,000
Total	**231,000**	**347,000**

138. Note that the figures relate to incremental costs estimated using the assumptions given in appendix 1. Accordingly, the low and high cost estimates were

calculated using different assumptions about how quickly the industry would decrease the frequency of re-fumigations.

139. The low estimate of incremental costs in Table 10 amount to approximately 0.15% of the annual value of dried fruit imports. The corresponding figure for the high estimate is approximately 0.2%.

140. As with the other commodities, the cost of improving fumigation and pest control at origin is difficult to predict. However, these costs would be offset by the long term prospect that the UK industry will be able to reduce the costs associated with re-fumigation in the UK. For these reasons, NRI is unable to estimate the cost of improving pest control and fumigation at origin.

Control Scenarios B and C

141. As discussed previously, the outcome of scenarios B and C is difficult to predict. As a relatively minor user, there may be no need for the dried fruit industry to alter its practices until 2005. However, the costs of methyl bromide fumigation might rise sufficiently after 2001 to make alternatives more attractive.

142. Assuming that a desire exists within the industry to pursue methyl bromide fumigation alternatives, control scenarios B and C should would allow sufficient time for most companies to adapt. Incremental costs would arise through improving pest control and fumigation at origin, though increased methyl bromide fumigation charges and through using phosphine or modified atmospheres for occasional re-fumigations in the UK after 2005. Small firms that are unable to improve fumigation and pest control at origin may face an uncertain future.

143. Dried fruit and nut importing companies may still decide that costs can be minimised by conducting final processing and packaging in the country of origin. In this event, jobs in UK packaging plants would remain under threat.

144. In summary, dried fruit industry compliance costs under scenarios B and C would be much lower compared with the costs under scenario A.

Nuts

Nut industry structure and fumigation practices

145. In 1997, the UK imported approximately 175,000 tonnes of nuts. The most significant imports were peanuts, dessicated coconut, almonds, cashews and pistachios. Other nut imports included Brazil nuts, walnuts, hazels and pecans. Countries of origin were numerous and included, the USA, India, Indonesia, the Philippines, China and Argentina.

146. Fumigation is conducted at origin before shipment. As with other fumigated commodities, standards of fumigation vary between countries of origin.

Some imports arrive in vacuum packs. This practice preserves freshness and eliminates infestation problems.

147. Imports arrive regularly through the year and only a small amount of stockholding occurs. Imports are either fumigated in containers on docksides or taken to warehouses for stack or chamber fumigations.

148. Approximately 15% of nut imports are re-fumigated in the UK using methyl bromide. The industry estimates that half these re-fumigations are conducted at docksides.

The impacts of the methyl bromide phaseout

Control Scenario A

149. The outcomes under this scenario are similar in nature to those predicted for the dried fruit industry. Figure 3 therefore applies to both the dried fruit industry and nut industry. However, the financial implications of the methyl bromide phase-out differ.

Table 11. Incremental Costs to the UK Nut Importing Industry in the First Year After the Introduction of Control Scenario A.

Incremental Cost Category	Incremental cost **Low Estimate (£)**	Incremental cost **High Estimate (£)**
Working Capital	27,000	40,000
Transport and handling	1,000	1,000
Insurance	1,000	1,000
Storage	42,000	63,000
Total	**71,000**	**105,000**

150. The figures in Table 11 are intended only to give indications of compliance costs, and are not precise quantifications. As such, Table 10 summarises the estimated incremental costs that the UK nut industry would bear in the first year after control scenario A is introduced. Costs in subsequent years are assumed to be substantially lower because the industry would react by putting much greater effort into improving practices at origin. Low levels of UK re-fumigation are achievable, and therefore annual compliance costs would eventually be low.

151. Note that the figures relate to incremental costs estimated using the assumptions given in Appendix 1. Accordingly, the low and high cost estimates were calculated using different assumptions about how quickly the industry would decrease the frequency of re-fumigations.

152. The low estimate of incremental costs in Table 10 amount to approximately 0.04% of the annual value of dried fruit imports. For the high estimate, the corresponding figure is approximately 0.06%.

153. As with the other commodities, the cost of improving fumigation and pest control at origin is difficult to predict. However, these costs would be offset by the

long term prospect that the UK industry will be able to reduce the costs associated with re-fumigation in the UK. For these reasons, NRI is unable to estimate the cost of improving pest control and fumigation at origin.

Control Scenarios B and C

154. The comments made above on the effects of these scenarios on the dried fruit industry also apply to the nut industry.

Imported timber

155. The Forestry Commission occasionally orders fumigations of imported timber, mostly on sawn timber and wooden packing material. The number of quarantine treatments has declined significantly over recent years because of improvements in the quality of both imported timber and the equipment used in Central and Eastern Europe. In 1996, the Commission ordered twenty three quarantine fumigations. By 1997, the number dropped to just six. So far this year, there have been another six interceptions. The Commission believes that the annual number of fumigations will not significantly rise above ten for the foreseeable future.

The impacts of the methyl bromide phaseout

156. There is no alternative to methyl bromide currently permitted in the UK for disinfesting imported timber. Under control scenario A, there would be no quarantine exemptions for methyl bromide, and assuming that no critical use exemptions were granted, imports containing infested timber would not be allowed to enter the UK. Importers would need to ensure that their imports are free of forestry pests. If methyl bromide was not permitted to be used most timber importers would cease importation.

157. Sulphuryl fluoride (sold under the trade name of "Vikane") is used widely in the United States as an effective timber fumigant. The manufacturers, the Dow Chemical Company, are interested in the potential for using the chemical in the UK and it is reported that discussions with the pest control industry on this matter are to take place soon. However, the Forestry Commission would have to approve Vikane's use before it could be used for UK timber quarantine fumigations.

158. Under control scenarios B and C, quarantine exemptions for methyl bromide will be allowed, though in time, the cost of methyl bromide fumigations will rise and pressure may build for a complete phaseout of methyl bromide from the market. In this event, UK importers of infestible wooden materials would either have to make efforts to ensure that their imports are pest free, or use Vikane, assuming that the Forestry Commission allows its use.

159. The compliance costs for control scenarios A, B and C may therefore be similar in the long run, and would include the costs of ensuring better pest control at origin and the incremental costs of using Vikane as an alternative to methyl bromide.

Commodities for which the phaseout will have minimal impact

Tobacco

160. The tobacco industry has pro-actively planned for the phaseout of methyl bromide by making substantial progress with the improvement of fumigation and pest control practices at origin. The industry is unlikely to be greatly affected by the phaseout.

Herbs and spices

161. Methyl bromide usage within the UK herbs and spices industry is very small. According to the Seasoning and Spice Association, most fumigations are for emergency disinfestations of warehouses and containerised produce. The industry is concerned that emergency use of methyl bromide should be permitted under the new regulations .

162. A few herbs and spices regularly require re-fumigation in the UK. Phosphine is a suitable but more costly alternative to methyl bromide. However, given that the industry uses little methyl bromide, the compliance costs of the methyl bromide phaseout should be low. Moreover, spices are high value commodities and therefore compliance costs would represent a minimal proportion of final product costs.

Cotton

163. Either no or very little methyl bromide is used in the UK cotton industry. The compliance costs of methyl bromide would be either zero or very small.

Cereals other than rice

164. According to information from the fumigation industry, cereal imports and cereal storage will be only minimally affected by the methyl bromide phaseout. Most cereals arrive in the UK from countries where standards of pest control are high. When fumigation is required, the usual fumigant is phosphine.

Conclusions

165. *Control scenario A:* If commodity importers act quickly to improve fumigations in the countries of origin, the frequency of re-fumigations conducted in the UK can be reduced dramatically before 2001. If this takes place, compliance costs after 1/1/2001 will be a small fraction of overall commodity procurement costs. However, costs would not be evenly distributed. Small importers, notably in the dried fruit and nut industries, would find difficulty effecting change at origin quickly. Their continued reliance on disinfestation in the UK may place a strain on their financial viability.

166. In practice, most commodity importers have consistently ignored quality problems at origin. If this situation persists, compliance costs after 1/1/2001 will

become significant. In the worst event, a shortage of space available for fumigations in warehouses would create a crisis.

167. Companies that run the risk of incurring significant compliance costs after 1/1/2001 are in the cocoa, dried fruit, coffee, rice and nuts industries. Importers of tobacco, herbs, spices, cotton, and cereals other than rice, will be either minimally or not affected by the phaseout of methyl bromide.

168. Costs of improving pest control and fumigation at origin will initially be high but will decline quickly after a period of intensive action. Eventually, commodity importers will gain financially because UK re-fumigation will only rarely be necessary.

169. *Scenarios B and C:* The costs of complying with controls suggested under these scenarios will be minimal compared with costs under scenario A.

170. *Exemptions:* There are no clear cases for critical use exemptions according to the criteria set out by the EC.

4. Structural Fumigations

Introduction

171. The survey data previously quoted indicate that about 95 tonnes of methyl bromide are used to fumigate buildings, such as mills and food factories. Flour mills are the main user and we estimate they account for 76 tonnes, while mills of other kinds and food factories account for about 18 tonnes. Rice mills are significant users, processing brown rice of mainly Indian and US origin, but the volumes processed are small compared to volumes of wheat processed by flour mills[4]. Many food factories do not use methyl bromide, and it is often used only for spot treatment of particular areas or production lines. Volumes used and frequency of usage are much lower than in flour mills.

172. For the remainder of this Section, we mainly focus on flour mills, making use of data provided by the National Association of British and Irish Millers (NABIM) and individual millers. The situation with rice mills and other kinds of food processors is discussed at the end.

Flour mills

Background to the flour milling industry

173. As indicated above, the UK industry processes about 5.4 million tonnes of wheat per annum, and with average extraction rates at around 80%, flour production is approximately 4.3 million tonnes. Since the beginning of the 1990s there has been a distinct upward trend in production of just over 1% per annum.

174. There are currently 32 milling companies in the UK operating a total of 73 flour mills, but when small stone ground millers and other small operators are excluded, between 50 and 60 units can be considered truly "commercial" (*pers. comm., NABIM).* An estimated 94% of total production is accounted for by mills processing in excess of 50,000 tonnes of wheat a year. With the recent merger of RHM and Spillers, two companies (RHM-Spillers and Allied Mills) will account for approaching 60% of total production. Throughout Europe, there is trend towards industry concentration and building of mills of ever higher capacity, but the process is much more advanced in the UK than in other countries.

175. Around 63% of flour is sold to bakers for breadmaking, usually in bulk form, while the next most important use is biscuit manufacture which accounts for about 14%. White bread alone accounts for 55% of total usage, and for the purpose of the present study, can be considered Britain's leading staple foodstuff.

176. Despite the progressive upgrading of plant, the average age of mill buildings is around 50 years, and some are more than 100 years old. Plant is typically replaced every 25 years, so output is normally increased by installing higher capacity

[4] Approximately 157,000 tonnes of rice were imported from these origins in 1997, compared to 5.4 million tonnes of wheat which were milled Taking account of volumes of rice trans-shipped via European ports, the total quantity milled may be of the order of 200,000 tonnes.

machinery in old structures, and by increasing the number of hours worked. New buildings are only erected occasionally, so it is a rare event for old infestation-prone structures to be replaced with modern structures which are relatively crack and crevice-free.

177. Nowadays leading millers try to run their mills at or near full capacity, i.e. in excess of 160 hours a week, 52 weeks a year. One major group programmes 8 hours down-time per week into its schedule. In practice there has to be some spare capacity to accommodate seasonal variations in demand; larger milling companies will typically do this by varying the use of one or more of its older mills which are run for fewer hours than the others, e.g. 100 to 140 hours a week. By contrast, this option is not open to the majority of companies that only have one mill.

177. Flour milling is a highly competitive commodity business, with low margins and minimal scope for product differentiation. Returns on incremental investments are low; industry sources consulted variously put them in the range of 8 to 12%. Notwithstanding this, the companies involved have a long-term commitment to the business and risks are very low, for which reason funds for modernisation or expansion of capacity are generally forthcoming.

178. Due to the demands of the retail trade, and in compliance with the Food Safety Act, quality standards are probably higher than in other European countries. This is frequently advanced by the trade as justification for critical use exemptions. The Danish and Dutch industries are already managing without methyl bromide, but British millers claim that their quality standards would not be acceptable in the UK.

Technical issues

179. Most mills are currently fumigated annually with methyl bromide, and are typically closed down for this purpose either at Whitsun or at Easter Bank Holiday. Methyl bromide is valued because it acts quickly, requiring the mill to be shut down for a mere 36 hours, and because it allows the miller to eliminate most infestation that has built up over the previous year. One miller is reported to fumigate twice a year in order to provide an additional quality assurance.

180. In the view of the industry, there is no ready-made alternative to methyl bromide. In the view of the industry, there is no ready-made alternative to methyl bromide. This includes the combination method employing low concentrations of phosphine and carbon dioxide plus heat, developed in, but stll awaiting registration in North America. The technical uncertainties regarding this technique are described in paragraph ?????? Starting in the early 1980s, RHM has sought to find ways of diminishing or eliminating its use - indeed RHM is the only company we know to have carried out such work. Several mills were disinfested with a programme of cleaning and spraying and trapping; this continued for periods of between 3 to 5 years, but eventually it was found that there was deep infestation, making it necessary to fumigate with methyl bromide.

181. In view of this experience, the general view of the trade is that IPM-based regimes without fumigation will not prove effective in the long run. The main problem is the infestation of spaces under wooden floors and inaccessible cavities,

which are typically found in the ageing structures in which milling equipment continues to be housed. It is considered impossible to eliminate or even control the level of infestation in these areas by such IPM regimes, and that without methyl bromide, insect populations will grow and in many cases get out of control leading to prolonged shut-downs.

181. In North America and the Netherlands many mills are routinely disinfested using heat treatment. Heating methods will prove more costly than in America due to the poor insulation of British mills, the absence of ready installed heating equipment, and a lack of hot summers when heating can be carried out economically. Direct heating arrangements are permissible in the Netherlands, but for insurance reasons, more costly indirect heating methods must be used in the UK.

182. A more serious problem, it is argued, is that heating technology is unproven under UK circumstances and is unlikely to meet the country's exacting quality standards. Bell (1997) notes that a Dutch mill had experienced damage to wooden floors due to shrinkage and warping, resulting in misalignment of roller mills, and persistent problems with splitting sieve covers. He also refers to problems which are likely to result from "the differential rate of expansion of different building materials - -, the liquification of greases and lubricants, weathering and ageing of certain materials and the inherent difficulty of obtaining an adequate temperature profile throughout the structure - -". However, an official of Manaba Mill in Rotterdam (presumably the same mill alluded to by Bell) informed NRI that although such problems had occurred in the early stages, these had been ironed out and their system had been working satisfactorily for four years. The age of the building (80 years) had not proved an obstacle to this achievement. There had been no reversion to methyl bromide on emergency or other grounds, although the fumigant is still permitted for spot treatment of flour silos. The Manaba system is now being emulated elsewhere in the Netherlands and in Germany. The key to successful operation was to ensure adequate circulation of warm air to prevent the build-up of hot spots.

183. Similar arguments are applied to alternatives involving the combined use of heat with modified atmospheres, with or without phosphine, though with phosphine there is the additional hazard of corrosion of equipment. All heat-based technologies are considered costly, due to the extended duration of treatment, the frequency of treatment required (it being claimed that it must be done as often as three times a year), and the consequent increase in down-time in an industry allegedly already working at near 100% capacity.

184. The last 18 months has seen the beginning of industry-wide co-operation, through a NABIM working party, to identify viable alternatives to methyl bromide. The most promising option identified is the combined use of heat + CO_2 + diatomaceous earth. An expected advantage of using this method is that lower temperatures are required to kill insects. Research is needed to assess heat requirements, to establish how best to circulate air, and to determine how best to use it in bringing about uniform temperatures within buildings. It is planned to carry out this research through a LINK project (cost £300,000) which is shortly to be submitted for approval by MAFF. The work programme lasts for three years, at the end of which NABIM will produce guidelines for the implementation for any recommended procedure. Results of the research are not expected to be available until 2003.

185. From the second half of the next decade, there exists the possibility of substituting methyl bromide with a totally new fumigant identified by researchers in Australia and the UK, and currently the object of an Australian patent application. It is claimed that the gas is a faster acting insecticide than methyl bromide, considerably more effective than phosphine at low temperatures, and relatively simple to manufacture. As such it might prove an effective substitute to both methyl bromide and phosphine. However to get it on the market would require a long process of toxicological testing, and it could easily take more than a decade to get it registered. Even if it found to be safe, there is no guarantee that the chemical would be registered, since the competent British authority is now reluctant to register broad-spectrum chemical insecticides of this kind.

186. While the trade expresses the above points of view, the opinion of pest-control experts is clearly divided. While some take the view that the industry has made all reasonable efforts to develop the use of IPM regimes, there is a contingent of experts who believe that it has not been sufficiently rigorous, and has tended to use methyl bromide as a catch-all remedy to clear up infestation on an annual basis. They typically argue that millers have been slow in recognising the problems raised by the planned phase-out of methyl bromide, because until the late 1990s, they have generally assumed that it was a scare which would subsequently blow over. In the same manner, it is argued that the RHM trials were mainly carried out in early 1980s when much of the insect-trapping technology with pheromones did not exist.

187. With regard to UK practice, it has been noted that confectionery and biscuit manufacturers have been successful in phasing out methyl bromide through the use of IPM procedures, combined with the gradual refurbishment of buildings. In one case, the manufacturer is housed in a complex seven-storey turn-of-the-century building, similar to many flour mills. It is also noted that UK millers use an Entoleter at the end of flour production to smash insects and their developing stages to ensure there are no live insects in the finished products. This provides an extra line of defence against infestation.

188. Netherlands and Danish authorities both report that their milling industries have been successful in their attempts to work without methyl bromide. However, a British pest-control specialist who visited three Danish mills found that IPM was being used without heat treatment, and indicated that the mills were unable to contain infestation at levels which would be acceptable in the UK (*pers. comm.*, IGROX Ltd.). Meanwhile, a study carried out for the Norwegian Pollution Control Authority, and involving three Scandinavian mills, indicated that heat treatment is effective in eradicating insect pests both in smaller, confined areas, and in larger buildings, though supplementary methods may be needed in certain areas where the necessary temperature is difficult to achieve (Stein Norstein, 1996).

189. There are clearly diverging views as to the feasibility and time-scale required for phasing out methyl bromide. We are not in a position to arbitrate these views, but we can draw some inferences from RHM's attempts to work without methyl bromide. The fact that the company was able to operate mills for three to five years without methyl bromide suggests that:

- most mills can probably manage with IPM regimes up to 2003 or thereabouts.

- by that stage viable alternatives will be found involving a combination of: (a) more intensive or improved IPM regimes and; (b) heat-based systems such as that used in the Netherlands, suitably modified on the basis of findings of UK research (such as that planned under the LINK project)

Consequences of the phase-out in flour milling

190. Assuming that there are no generalised critical use exemptions, we may safely predict that under all three Control Scenarios, companies will fumigate most of their premises in or somewhat before the year 2000. If companies implement improved cleaning regimes, few if any mills are likely to need disinfestation until 2003, giving them two to three years extra breathing space in dealing with the problem. By that time, we believe that the industry will probably have identified acceptable alternatives allowing it to do without methyl bromide permanently.

191. The foregoing is our assessment of the most likely consequence of the phase-out. However, due to the technological uncertainties involved, there are finite risks that infestation will get out of control in one or more of the mills, above all under Scenario A, which involves a complete phase out by the Year 2000. We do not believe the level of such risks and associated costs can be meaningfully quantified, but risks of this nature need to be allowed for through emergency use provisions.

Cost implications - assuming no critical use exemptions

192. We make our projections on the assumption that, under all three scenarios, the flour milling industry will successfully substitute for methyl bromide by 2003, and avoid any major closures that will disrupt national food supplies. However, as we have just stated, we are not 100% certain about their ability to do this, so in the next section we suggest exemptions that might be made if industry is unsuccessful.

193. Our cost projections are made on the basis of low and high cost projections, as follows:

194. *Low-cost projection.* Involves intensified cleaning, spraying and trapping operations, which some pest-control specialists believe to be sufficient to avoid major infestation.

195. *High-cost projection.* Involves intensified cleaning, spraying and trapping, plus a heat-based treatment such as that to be piloted through the LINK project. It is assumed that mills will have to be shut down three times a year for 90 hours each time; this compares with 2 shutdowns of about 56 hours by the Madama mill in Rotterdam, and reflects the higher specification at which the British food industry is aiming. In practice it is likely that industry will find ways of reducing down-time below this level, which should be treated as an upper limit.

196. Appendix 2 shows our spreadsheet costing of the cost impact under the two projections. The cost factors we consider are:

(a) the cost of increased down-time resulting from the new measures. This is estimated as the cost of increased capacity and related fixed operating costs for new mills which must be built to make up for the lost capacity.

(b) the incremental costs of pest-control measures. With IPM regimes, increased labour costs are largely compensated for by the elimination of the fumigant, and incremental costs are small (indeed one pest control expert believes that there will be an overall cost saving). We could obtain no information from British millers on the costs of installing heating/modified atmosphere systems, and the best we can do at this stage is to make some very rough estimates in the light of information provided for the Madama mill in Rotterdam. The main cost is the investment in heating systems. Madama is an extraordinarily large mill (20,000 cu m; 80-85 tonnes per hour of wheat input), and the additional investment required is approximately Fl.500,000[5]; this did not include water treatment and boiler systems which had already been installed. We have allowed an average £150,000 investment per average mill in the UK (average throughput about 9 tonnes of wheat per hour), including where needed, additional water treatment and boiler systems.

(c) the cost of increased silo storage capacity to cover demand during periods of closure for heat/modified atmosphere treatment. We assume that extra capacity is needed to cover a quarter of the production in the additional periods of closure, and that millers will cover the remaining demand by staggering closures. This is only applicable to the high-cost scenario.

197. These estimates involve a high level of approximation, but we believe that they provide high and low bounds to the range of probable costs.

198. On the basis of these assumptions, we find that the industry must bear the following additional investments:

[5] Fl.3.18 = £1

TABLE 12: ESTIMATE OF ADDITIONAL INVESTMENTS REQUIRED BY THE MILLING INDUSTRY in £ millions	Low cost projection	High cost projection
Additional milling capacity	7.9	33.1
Additional silo capacity		20.7
Heating capacity		11.0
Working capital	0.6	2.2
Total	8.4	67.0

199. The phase out of methyl bromide will require significant investment on the part of millers over a period of several years. In the low cost projection, plant capacity must be increased by 1.1%, and additional investments are £8.4 millions. In the high cost projections plant capacity must be increased by 4.5%, supported by additional investments of £67.0 million. The main components of this are increased milling and silo capacity.

200. Our cost projections apply broadly to all three scenarios. However costs will be borne earlier under Scenario A than under scenario C, and even earlier than under scenario B. Moreover, the longer the phase-in period, the easier it will be for the industry to find ways of reducing costs. For example if effective new gaseous insecticides were in commercial production by 2005 or shortly thereafter, the industry might escape significant investment in new plant, heating systems and silos.

Impact on small millers

201. The high and increasing level of industrial concentration in flour milling is indicative of economies of scale which favour the larger players. Given the lumpy nature of investments, larger millers can more easily match supply and demand and distribute their flour within an economic radius, often considered around 120 miles. Smaller mills will need to invest proportionately more in storage to cover demand during additional down-time; alternatively they may be able to cover this demand by entering into co-operative arrangements with other millers. New challenges, such as that posed by methyl bromide, are likely to accentuate scale economies favouring the larger players; smaller companies can generally employ fewer specialist staff to address such matters.

Impact on other food-processing industries

202. Most rice millers still use methyl bromide for structural fumigation, but more than one company has dispensed with it altogether through the use of IPM techniques. In the case of one of these companies, the mill is housed in an old building dating from 1930. In view of this we believe that other millers will be able to achieve the

same result without great difficulty. Due to the saving in fumigant, the incremental costs to the miller will be small.

203. Other food manufacturers generally make less use of methyl bromide and are likely to experience less difficulty in switching to alternative pest control methods. In this regard it is instructive to cite the experience of a biscuit manufacturers, which does not use methyl bromide at all, but relies on a regime of weekly cleaning, inspection, third party audits and spraying in critical areas. The firm has been able to dispense with methyl bromide despite having an unusually old building. Kelloggs also manages to do without methyl bromide, and attributes its success to a combination of IPM techniques and high quality grain with minimal infestation. However, grain quality may not be a very significant factor, since major pest problems in food factories and mills are normally associated with moths and beetles which are not introduced with the raw materials but which are endemic to the factory environment.

204. In adopting cleaning-based regimes such firms will experience increased labour costs, but will save on fumigants. The overall cost impact is likely to be small.

207. Cheese manufacturers constitute one category of enterprise particularly vulnerable to the phasing out of methyl bromide. It is commonly used to eradicated (or reduce to an acceptable level) the mites on and in Cheddar, and in some sheep, goat and Caerphilly cheeses. These cheeses are matured for many months, up to 24 months for Cheddar, at humidities around 80% and temperatures around 8 to 10 C. There is considerable manual handling to equalise the maturing on shelving, and to equalise pressures. Vacuums are used to remove the majority of mites, and contact insecticides are used on the shelving and racking.

205. Methyl bromide is used over 48 hour exposure periods (the eggs and hypopal stages of mites are not easy to kill) and over closed weekends. Phosphine would take about 16 days at these low temperatures, making it unfeasible, because the cheeses would need manual handling during this period and all work in the rest of the dairy would be halted (HSE practice for worker safety). Controlled atmospheres could work, but would take even longer (3 to 4 weeks). It is difficult to see how the oxygen could be reduced and kept below 1% for the length of time which according to CSL data is required to kill mites, even if there was a solution to worker involvement in turning the cheeses.

206. We conclude that the phase-out of methyl bromide may endanger the livelihood of manufacturers of certain kinds of cheeses.

The case for exemptions

207. *Flour-milling.* We believe the best way of ensuring industry applies maximum attention to finding and implementing alternative pest control methods is by avoiding automatic exemptions on critical use grounds. If scenario (A) is implemented, we would suggest no exemptions whatsoever for the first two years, i.e. up to December 31, 2002, because fumigations conducted in the year 2000 could provide a two-year leeway. Companies could thereafter seek emergency exemptions

but would then have to make a special case. Save overwhelming evidence that mills are unable to meet official food standards, all such exemptions might be eliminated by the year 2005.

208. Given scale economies referred to above, a case could be argued for greater leniency with smaller milling companies.

209. *Other food-processing.* The manufacture of certain kinds of cheese appears to justify critical use exemptions on the grounds that it is critical to the dairy industry in parts of the country.

5. Other Uses

Aircraft fumigations

210. According to figures supplied by the fumigation industry, 0.7 tonnes of methyl bromide was used in 1997 to fumigate aircraft in the UK. Assuming an average dosage of 11.25 kg per aircraft, the number of treated aircraft was approximately 60.

211. Fumigations are designed to kill rodents and cockroaches. Rodents are a particular problem because they destroy aircraft electronic systems. The need to take swift action once rodents have been detected is therefore very important. Occasionally, fumigations are required in aircraft that are suspected of containing rats infested with plague carrying fleas.

212. Only a few companies regularly disinfest aircraft in the UK. Their customers come from among UK and overseas airline companies.

213. Fumigation with methyl bromide minimises treatment times and therefore reduces the substantial costs that airlines incur when aircraft are out of service. There is currently no alternative fumigant for disinfesting aircraft in the UK. Fumigation with hydrogen cyanide was discontinued in the mid-1970s, and the gas is no longer registered in the UK. For fumigation companies, re-registration for aircraft usage would be too costly compared with the limited business that would be generated.

214. Cockroach infestations can be treated using newly developed cockroach traps. The traps are effective over a long period, are harmless to humans and could be used for routine disinfestations without significant extra cost to airlines.

215. Rodent infestations are much more difficult to treat. Current baiting technology does not permit routine treatments and requires aircraft to be out of service for approximately five days. Preliminary information suggests that the cost of keeping an aircraft on the ground for this period is at least £2,000,000.

216. If no exemption is made for aircraft disinfestation after the phaseout of methyl bromide, aircraft fumigators in the UK will cease their activities. Airlines that allow rodent infested planes to fly would attempt to find alternative locations where either methyl bromide or hydrogen cyanide are still used. However, the number of alternative locations is limited, and would diminish as the world-wide phaseout of methyl bromide gathers pace.

217. Under the proposed criteria in the new regulation it is possible that aircraft fumigation will not qualify for an exemption. The application procedures for emergency exemptions may be too cumbersome to be of practical use to airlines. Only a few fumigations may meet the quarantine definition.

218. In view of both the limited quantities of methyl bromide used for aircraft fumigation in the UK, and the involvement of public safety, NRI believes that a strong case could be made either for an emergency use exemption for aircraft fumigation or for an amendment of the criteria. Pressure could still be applied to airline companies to find alternatives to methyl bromide for disinfesting aircraft.

Currently, the only alternative to methyl bromide for controlling rodents would be the use of baiting and trapping procedures, and which would require aircraft to be out of service for several days rather than the approximately ten hours required for fumigation. A major airline has indicated that baiting and trapping as an alternative to methyl bromide for rodent control is highly undesirable. This is because of the very high costs involved in the extra delay time whilst an aircraft is on the ground, these costs varying from £300 to £1000 per minute depending on the type of aircraft, and the schedule that it normally operates.

Ship Fumigations

219. According to the results of NRI's fumigation service company questionnaire, at least 1.4 tonnes of methyl bromide was used to fumigate ships in 1997. This quantity is sufficient to have treated four ships. However, individuals in the fumigation industry believe that a greater number of ships were fumigated. They propose an estimate of 12. It is also reported that, in 1997, a special fumigation of a ship became necessary in which a total of seven tonnes of methyl bromide was employed.

220. Fumigations are designed to kill rats and cockroaches, and are more common on ships that carry foodstuffs.

221. Ship fumigations are occasionally ordered by the Marine Safety Agency. More often, ship owners decide that fumigations are necessary, especially when ships come out of commission or change ownership.

222. Methyl bromide fumigation is a cheap and convenient method of disinfesting ships. Its fast pesticidal properties allow ships to be out of service for minimal periods. The most effective alternatives are rodent baits and newly developed cockroach traps. The incremental costs of using these alternatives will be minimal, especially if they are used to prevent, rather than cure, infestations.

Fumigation of infestible wooden materials for export to Australia and New Zealand

223. To prevent the introduction of forestry pests, Australian and New Zealand pre-shipment regulations require that imports containing infestible wooden materials, including pallets and packing materials, should be treated against pests in the country of origin. The regulations allow two options, heat sterilisation and fumigation with either methyl bromide or sulphuryl fluoride (sold under the trade name of "Vikane").

224. Australian pre-shipment regulations also insist that timber floors of containers are either impregnated with insecticide to create permanent immunisation against pests, or failing this, treated with either Vikane or methyl bromide as a temporary solution. Information from the UK fumigation industry indicates that containers with impregnated floors are easy to find.

225. Usual UK practice is to fumigate infestible wooden materials in containers using methyl bromide. Using information gained from the fumigation industry, NRI estimates that 8300 export containers were treated with methyl bromide to comply with Australian and New Zealand quarantine regulations in 1997. The type and value of these exports is not known. Likewise, information on the type, volume and value of exports which are not treated in containers is unavailable. However, assuming that most of the trade is in manufactured and processed goods, the value of affected exports is undoubtedly many millions of pounds.

226. Vikane is not currently registered in the UK. However, its manufacturers, the Dow Chemical Company, are reported to be having discuusions with UK industry in the near future regarding marketability of the chemical and possible future registration for the treatment of wood.

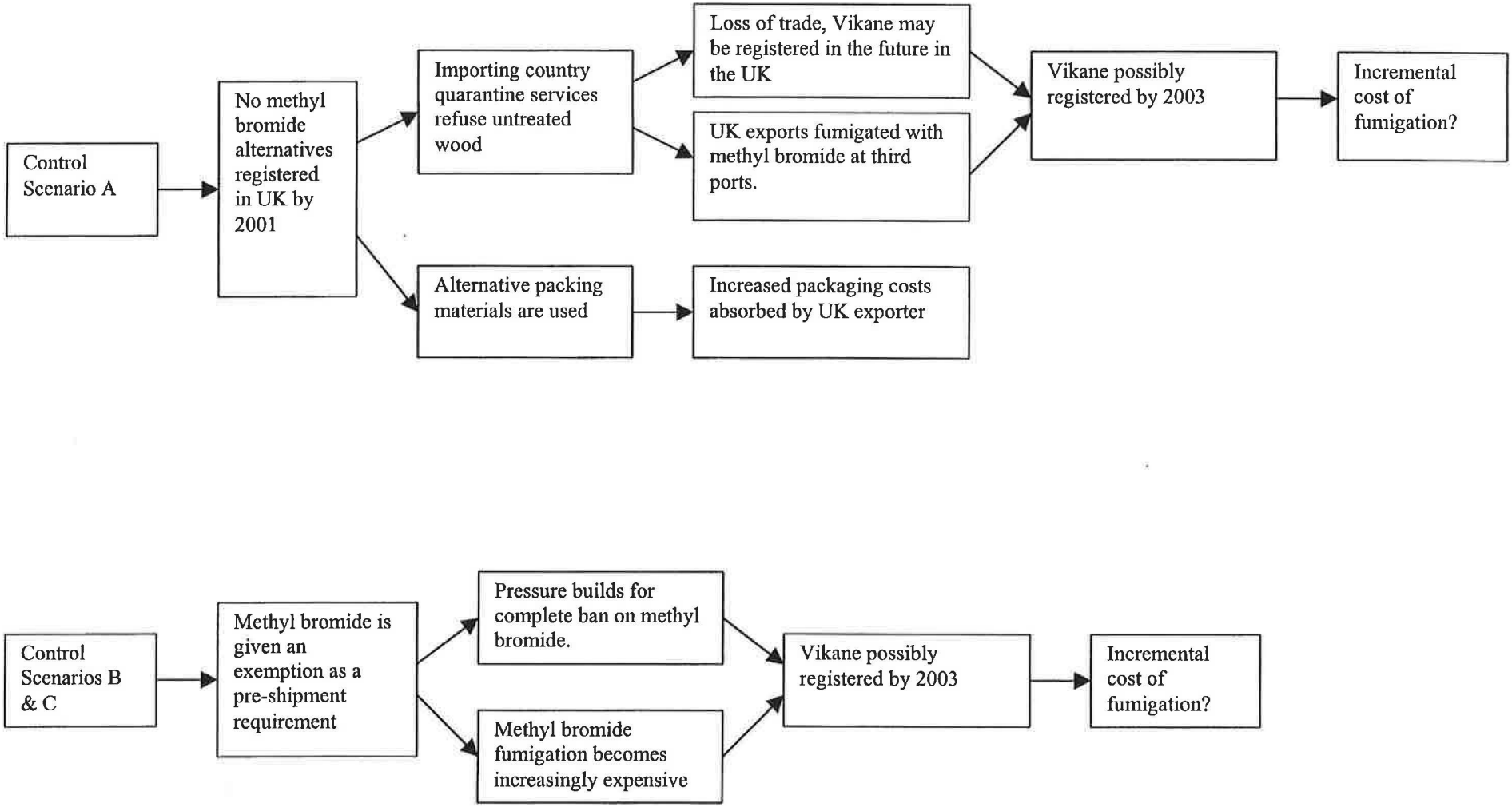
227. The impacts of methyl bromide phaseout are outlined in figure 4.

Control Scenario A

228. There are no exemptions for pre-shipment and quarantine uses under scenario A. The relevant exports would not qualify for critical use exemptions under the criteria currently proposed by the EC. In these circumstances, exporters might react in the following ways:

- By using alternative, non-infestible pallets, crates and packing materials. The food industry already uses plastic pallets. Non-infestible dunnage is also available. However, these alternatives are expensive.

Figure 4. Export of infestible wooden materials to Australia and New Zealand.



- By fumigating in third countries. After 2001, many countries will still allow methyl bromide fumigations. Since Denmark withdrew methyl bromide at the beginning of 1998, a proportion of Danish exports to Australia and New Zealand have been fumigated in third countries. However, in the UK's case, the British Chamber of Shipping believes that trans-shipment of exports would be prohibitively expensive.

- By diverting exports from Australia and New Zealand. This would be the only option for products containing wood which can not be heat sterilised or impregnated with insecticide.

229. UK exporters would continue to bear incremental costs until Vikane becomes available. While treatment times are similar, Vikane and methyl bromide are not perfect substitutes. Concerns have been raised regarding Vikane residues which remain in food after fumigation. Methyl bromide residues also occur but much knowledge has been accumulated, and residues are therefore controllable and predictable.

230. Vikane is not currently sold in the UK and therefore its cost relative to methyl bromide is unknown because. However, in the absence of competing chemicals, Vikane might be introduced at a high price. The fumigation trade estimates that Vikane might be four to five times more expensive per treatment.

Control Scenarios B and C

231. Under these scenarios, exports of wood and wooden products to Australia and New Zealand would gain pre-shipment and quarantine exemptions after 2001. As time passes, the cost of methyl bromide fumigations will rise and pressure may build for a complete phaseout of methyl bromide. However, by the time these effects become critical, Vikane will probably have been registered in the UK. The only incremental costs after Vikane is introduced would arise from the greater cost of the fumigant.

Other Pre-Shipment Uses

232. Apart from Australia and New Zealand, several other countries occasionally require pre-shipment fumigations. NRI estimates that the total number of containers treated in 1997 was 5,000. According to information supplied by the fumigation industry, the major categories of exports were used clothes (mostly to East and West Africa), rice, perfumery, chemicals, motor parts, tyres and personal effects. The major destinations were Africa, USA, Eastern Europe, Singapore, China, Malta and Cyprus.

233. NRI was unable to discover the specific foreign regulations that require pre-shipment fumigations. Consequently, we are unaware what, if any, alternative treatments are permitted. If no pre-shipment exemptions are granted as part of methyl bromide controls (as under scenario A), exports may have to be diverted or, in some cases, may have to cease entirely. Clearly, the loss of export revenue from used clothes, the largest trade volume in this category, would not be great. However, the

export value of processed and manufactured goods could be substantial. Shippers of clothing to countries in East and West Africa indicated that containers are fumigated in the UK prior to export because this is a requirement of the governments of those countries. Such fumigations would, therefore, qualify as 'pre-shipment' treeatments.

234. In some instances, Vikane, if it became registered, might be permitted as an alternative to methyl bromide for some uses but these are unlikely to include food commodities because of chemical residue problems.

Plant health

Current uses

235. According to industry contacts provided by MAFF, the major user of methyl bromide for plant health purposes is the chrysanthemum cuttings import trade. Approximately half the imports come from Kenya, and a similarly large proportion comes from the Canary Islands. All the cuttings which arrive in the UK from Kenya are fumigated against quarantine pests with a mixture of carbon dioxide and methyl bromide. All the Canary Island cuttings are fumigated at source and no re-fumigation is required in the UK. The total amount of methyl bromide used in this context, in the UK, is approximately 40kg per year.

236. The UK plant cutting export industry uses small amounts of methyl bromide. In particular, New Zealand quarantine regulations require methyl bromide fumigations for live plant material. However, the volume of trade is small and the total quantity of methyl bromide used probably does not exceed 2kg.

The impacts of the methyl bromide phaseout

237. Methyl bromide is the only fumigant registered in the UK which can be used to disinfest live plant material. Under control scenario A, quarantine uses of methyl bromide will not be permitted. If no suitable third country fumigations can be arranged, imports of chrysanthemum cuttings from Kenya would have to cease. The value of imports from Kenya is approximately £1 million, and the UK sales value is approximately £1.8 million. UK exports of plant cuttings to countries requiring plant fumigations would also cease.

238. Under control scenarios B and C methyl bromide would be available under quarantine exemptions. However, as time passes, the cost of methyl bromide fumigations will rise and pressure may build for a complete phaseout of methyl bromide. The plant cuttings industry might therefore have to find alternatives to UK methyl bromide fumigations, even if this involves methyl bromide fumigations in reputable third countries.

Disinfestation of museum artefacts

239. Methyl bromide continues to be used by some museums to disinfest artefacts arriving in the country, or if they become infested in museums. The total amount of fumigant used for this purpose is, however, very small, and has been reduced in recent

years by the introduction of alternative technologies by several museums including employment of modified atmospheres and, for some materials, freezing. The impact of phaseout of methyl bromide, even under scenario A, should not present a problem technically to those museums still using the fumigant, because alternatives methods of disinfestation are available. However, it may be a problem where adoption of alternatives has not been budgeted for by 2001. There should be no problem in phasing out the use of methyl bromide on artefacts under scenarios B and C.

The impact on fumigation service companies

240. The impacts of the methyl bromide phaseout on the fumigation service companies are presented in Figure 5.

Control Scenario A

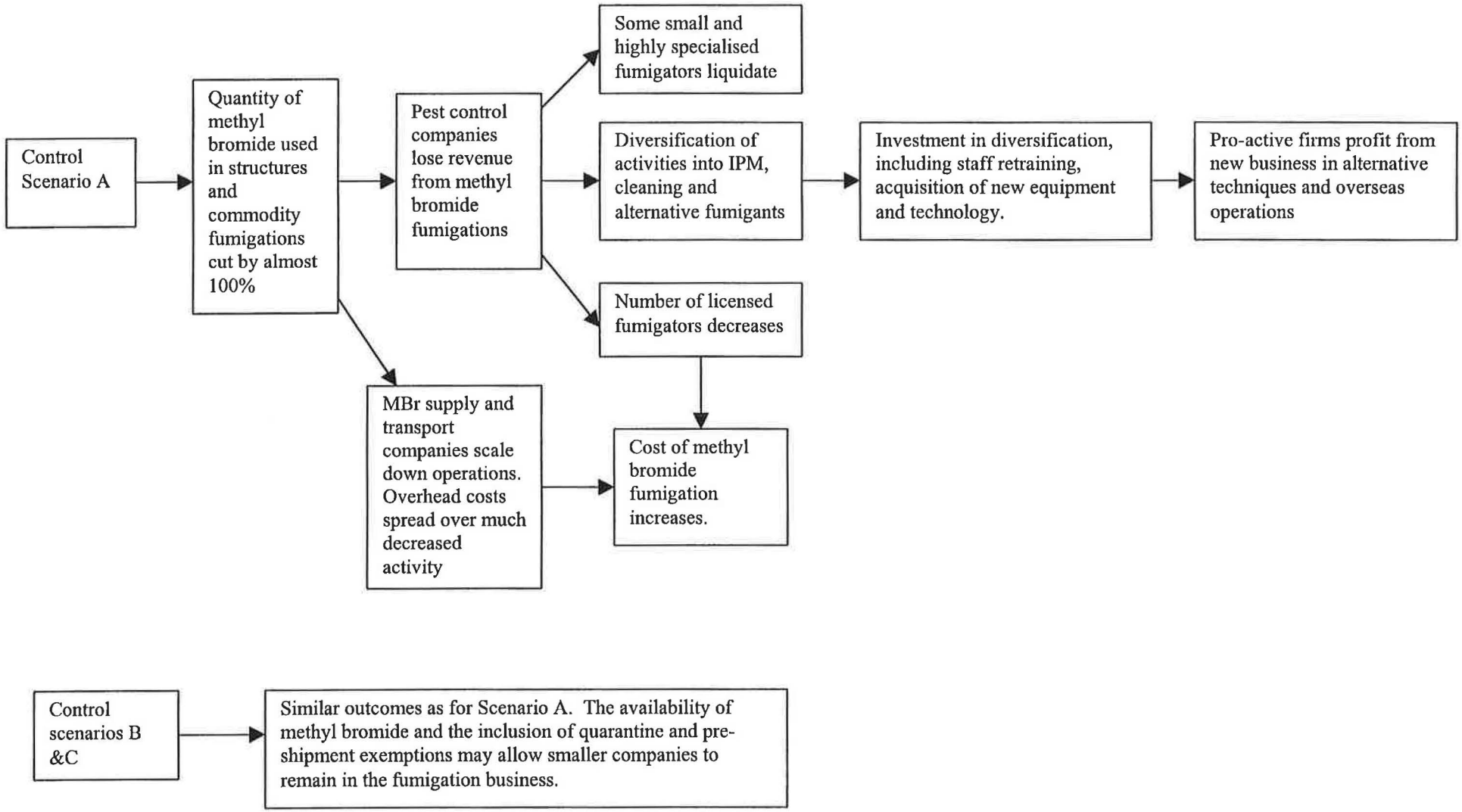
241. Assuming that only a few critical use exemptions are granted, virtually all commodity and structural fumigations would cease. Fumigation companies would lose revenue and some small companies, which specialise in methyl bromide fumigations, would liquidate unless diversification were possible. From questionnaire responses given by British Pest Control Association members, NRI estimates that four companies might be forced to liquidate their businesses. The combined annual turnover of these companies is approximately £615,000. Three of the companies gain most of their income from soil fumigations.

242. Overall, the number of licensed methyl bromide fumigators would significantly decline because there would be too few fumigation opportunities to maintain licenses.

243. This would almost certainly lead to increased methyl bromide fumigation charges. The majority of pest control and fumigation companies will be able to diversify their activities and generate profits from new business in alternative techniques and overseas operations[6]. According to the BPCA (pers. comm.):

[6] At least one major UK pest control company is currently preparing for new business in improving commodity pest control and fumigation in countries of origin.

Figure 5. Fumigation Service Companies



"Most fumigators who offer a diverse range of pest control services will actually benefit from the phase out of methyl bromide because the alternative solutions are more expensive and less efficient. This will, therefore, lead to more business for servicing companies."

244. Pesticide supply and transport companies would scale down or cease their methyl bromide operations. Those companies that remain in the business would have to spread their overhead costs over much decreased activity. This would lead to further increases in the costs of methyl bromide fumigations.

245. There is a possibility that no companies would be willing to supply methyl bromide. In these circumstances, scenario A would effectively become a complete ban on all uses of methyl bromide, including uses permitted under critical use and emergency exemptions.

Control Scenarios B and C

246. Under these scenarios, the availability of methyl bromide after 2001 might allow small companies specialising in methyl bromide fumigations to remain in business by giving them more time to adjust to changes in regulations. For other diversified companies, the outcomes of these two scenarios would be similar to scenario A.

247. There is a possibility that in the absence of price controls, supply companies will profit from the scarcity of methyl bromide. Users of methyl bromide may compete with each other to secure their methyl bromide requirements and thereby encourage price rises. However, the profits earned by supply companies would be reduced by the increased cost of purchasing methyl bromide from the manufacturers, who will increase prices to cover increased costs of production once their output declines.

Conclusions

248. If quarantine and pre-shipment exemptions are not granted as part of methyl bromide controls, two groups of UK traders will be significantly affected. First, exporters of infestible wooden materials to Australia and New Zealand will incur incremental costs from using non-infestible packing materials, and in some instances, may have to divert exports to alternative destinations. Second, importers of chrysanthemum cuttings will not be able to gain phyto-sanitary certificates from MAFF. In the first case, the introduction of Vikane early in the next century would solve the problem. In the second case, imports of chrysanthemum cuttings that can not be given a credible phytosanitary certificate at origin, will have to cease.

249. Overall, the fumigation service industry will gain from the phaseout of methyl bromide. The major companies have already started preparing for new business in alternative pest control services. Under control scenario A, some small specialist companies may liquidate.

250. *Cases for exemptions:* There are no clear cases for critical use exemptions. However, given that aircraft fumigation involves issues of public health and safety, we believe that a special exemption should be made for this use. Another special exemption may be justified if pre-shipment and quarantine exemptions are not granted for exports of infestible wooden materials to Australia and New Zealand. Estimating the compliance costs that these exporters would incur has not proved possible but in all likelihood, the costs would be high. The exemption could be withdrawn if Vikane were to be registered.

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Appendix 1.

Assumptions used in commodity imports compliance cost analyses

A. General assumptions

1. No exemptions are made for commodity imports

2. The weighted average cost of capital is 10% of the principal per year

3. The cost of re-routing commodities to third party warehouses is £5 per tonnes

4. Current prices and costs represent future values

5. Stack fumigations take on average 9 days longer when using phosphine instead of methyl bromide

B. Additional assumptions made for cocoa imports

1. For the low incremental cost estimate, the industry is assumed to reduce the overall number of UK re-fumigations by 75%. However, recognition is made that improving pest control in Ivory Coast will be difficult. Consequently, the UK industry is assumed to hold six extra of stock in between the last shipment of the old season and the first shipment of the new season.

2. For the high incremental cost estimate, the industry is assumed to reduce the overall number of UK re-fumigations by 25%. Recognition is made that improving pest control in Ivory Coast will be difficult. Consequently, the UK industry is assumed to hold nine extra of stock in between the last shipment of the old season and the first shipment of the new season.

3. All fumigations will be conducted in warehouses, where sufficient space will be available. Fumigating with phosphine on docksides will be prohibitively expensive due to ground slot charges and container demurrage.

4. 50% of UK re-fumigation and storage costs are charged to cocoa exporters. NRI was unable to discover the true industry wide figure but discussions with individual companies lead us to believe that 50% is a realistic or possibly conservative estimate.

C. Additional assumptions made for coffee imports

1. For the low incremental cost estimate, the industry is assumed to reduce the overall number of UK re-fumigations by 75%.

2. For the high incremental cost estimate, the industry is assumed to reduce the overall number of UK re-fumigations by 25%.

3. Fumigating in ports becomes financially unviable due to ground slot charges and demurrage for containers undergoing phosphine fumigation. All fumigations will be conducted in warehouses, where sufficient space will be available.

4. 75% of UK re-fumigation and storage costs are charged to coffee exporters. NRI was unable to discover the true industry wide figure but discussions with individual companies leads us to believe that 75% is a realistic figure.

D. Additional assumptions made for rice imports

1. For the low incremental cost estimate, the industry is assumed to reduce the number of UK re-fumigations by 75%.

2. For the high incremental cost estimate, the industry is assumed to reduce the number of UK re-fumigations by 25%.

3. Current practices of fumigating in ships, barges and containers at ports becomes financially unviable due to ground slot charges and demurrage. All fumigations will be conducted either in warehouses or silos.

4. Fumigation costs remain unchanged. Phosphine fumigations in warehouses and silos are cheaper than methyl bromide fumigations in containers. However, this saving will be offset by the incremental cost of dis-infesting silo machinery.

E. Additional assumptions made for the dried fruit and nut industries

1. For the low incremental cost estimate, the industries are assumed to reduce the number of UK re-fumigations by 50%. The scope for effecting quick reductions is assumed to be lower in the fruit and nut industries than in other commodity importing industries.

2. For the high incremental cost estimate, the industies are assumed to reduce the number of UK re-fumigations by 25%.

3. Fumigating in ports becomes financially unviable due to ground slot charges and demurrage for containers undergoing phosphine fumigation. All fumigations will be conducted in warehouses, where sufficient space will be available.

4. Unchanged fumigation costs. Per tonne of dried fruit, phosphine fumigations of dried fruit and nuts in stack are approximately equal in price to methyl bromide fumigations conducted in containers.

APPENDIX 2: BASIC ASSUMPTIONS AND WORKINGS FOR FLOUR MILL COSTS OF COMPLIANCE

Note: all costs are in £ except where otherwise stated

1. Miscellaneous data

Annual flour production, million of tonnes	4.40
Average extraction rate %	80%
Average price of flour per tonne delivered to bakeries	200
Average price of flour to bakeries as percentage of retail price of bread	20%
Cost per tonne of storage capacity	2,800
Fixed operating costs per tonne of flour - medium to high capacity mill	11.3
Cost of capital in real terms (net of inflation)	10%

2. Operational hours and downtime

Current situation:

Number of hours available per year, per mill		8,740
Level of down-time:		
(a) cleaning - 1 x 8-hour shift per 5 weeks		
i.e. 10 x 8 hours per annum	80	
(b) fumigation - 36 hours per annum	36	
(c) other down-time 2.5% - 4.2 hours/week	219	
Total down-time		335
Average milling time per mill		8,406

Low-cost projection - IPM regime:

Number of hours available per year, per mill		8,740
Level of down-time prior to change:		
(a) cleaning - 1 shift per fortnight		
i.e. 26 x 8 hours per annum	208	
(b) other down-time 2.5% - 4.2 hours/week	219	
Total down-time		427
Average milling time per mill		8,314

High-cost projection - IPM + heat and modified atmospheres:

Number of hours available per year, per mill		8,740
Level of down-time:		
(a) cleaning - 1 shift per fortnight		
i.e. 26 x 8 hours per annum	208	
(b) heat + fumigation - 3 x 90 hours per annum	270	
(c) other down-time 2.5% - 4.2 hours/week	219	
Total down-time		697
Average milling time per mill		8,044

Calculation of percentage increase in fixed costs per tonne of flour:	**Low cost projection**	**High cost projection**
Hours down-time after change	427	697
Hours down-time before change	335	335
Decrease in hours worked	92	362
Average hours worked before change	8,406	8,406
Decrease in hours worked %	1.09%	4.31%
Increase in fixed costs per tonne of flour %	1.11%	4.50%

3. Cost of new plant, with effective ouptut capacity of 13 tonnes per hour* of flour (extra silo costs excluded):	**Building**	**Equipment**	**Total**
Cost of new plant:			
using existing site and buildings	5,000,000	5,000,000	10,000,000
on green-field site	20,000,000	5,000,000	25,000,000
Useful life	50 years	25 years	
Annuity factor at 10% cost of capital	9.92	9.08	
Annualised plant cost:			
using existing site and buildings	504,286	550,843	1,055,129
on green-field site	2,017,146	550,843	2,567,989
Annualised cost per hour milling time:			
using existing site and buildings	60	66	126
on green-field site	240	66	306
Annualised cost per tonne of flour			
using existing site and buildings	4.6	5.0	9.7
on green-field site	18.5	5.0	23.5

Additional investment by the industry (assuming 50% of new Plant is on green-field sites):	**Low cost projection**	**High cost projection**
annual flour production	4,400,000	4,400,000
increase in downtime as a % of operational hours	1.11%	4.50%
additional annual production capacity required (tonnes)	48,692	198,023
annual production of 13 tph plant	108,076	104,566
numbers of additional plants required**	0.5	1.9
average cost of an additional plant (assuming 50% on existing site and 50% new site)	17,500,000	17,500,000
additional investment required to cover additional capacity required	7,884,377	33,141,015

* new plants are likely to be 13 tph or more capacity

** considering that the industry seeks to maintain constant level of capacity utilisation, we treat the investment as fungible

4. Fixed costs per tonne of flour production - assuming plant capacity of 8 tonnes per hour

Fixed operating costs/tonne production	11.3
Total fixed costs including capital costs:	
using existing site and buildings	21.0
on green-field site	34.8
average assuming 50:50 split	27.9

Calculation of increase in fixed costs/tonne of flour	**Low cost projection**	**High cost projection**
Increase in fixed costs per tonne of flour %	1.11%	4.50%
Fixed costs per tonne of flour produced (see above)	27.9	27.9
Increase in fixed costs/tonne of flour	0.31	1.25

5. Additional investment in working capital:

National production of flour (tonnes)	4,400,000	4,400,000
Percentage increase in downtime	1.1%	4.5%
Fixed operating costs per tonne production	11.3	11.3
Increase in working capital required to cover lower output	550,218	2,237,663

6. Cost of extra silo storage for flour (for high-cost projection only)

Cost per tonne of storage capacity	2,800	
Useful life	25	years
Annuity factor at 10% cost of capital	9.08	
Annualised cost per tonne storage capacity	308	
Annual hours worked	8,044	hours
Extra hours of continuous downtime (90-36 hours)	54	hours
Increased storage hours required (25% of extra downtime)	13.5	hours
Extra hours storage as % of total hours worked	0.17%	
Extra cost per annum per tonne throughput	0.52	
Additional investment by the industry:		
annual flour production (tonnes)	4,400,000	
increase in stockholding (tonnes)	7,385	
cost per tonne of storage capacity	2,800	
therefore additional investment =	20,677,566	

7. Change in pest control costs/tonne of flour	**Low cost projection**	**High cost projection**
Additional plant costs:		
High cost projection (assume 8 tonne flour per hour mill)		150,000
annualised cost, assuming 25 year life		16,525
annualised cost per operating hour		2.05
annualised cost per tonne of flour		0.26
Additional investment by the industry (73 mills)		10,950,000
Pest control costs/tonne flour		
before change	0.38	0.38
after change		
cleaning, trapping and spraying	0.57	0.57
fuel and modified atmosphere treatment		0.10
annualised cost of additional investment		0.26
total costs after change	0.57	0.93
Increase in pest control costs/tonne of flour	0.19	0.55

Appendix 3. Questionnaire and aide-memoire

DETR METHYL BROMIDE PHASE-OUT STUDY
QUESTIONAIRE FOR SERVICE COMPANIES, AUGUST 1998

Name of respondent: _____

Position: _____

Company: _____

Name of parent company (if one exists): _____

What are your main business activities: _____

_____

What is your company's approximate annual turnover: £_____

What percentage of turnover is accounted for by:

(a) pest control: _____ **(b) fumigation:** _____

Approximately what percentage of your fumigation turnover is accounted for by Methyl Bromide? _____

How much Methyl Bromide did you use during 1997? _____ **tonnes**

Approximately what quantity did you use for fumigation of:

	Numbers and/or dosage rate **	kg used*	Percentage of total*
Buildings?			%
Containers for export?			%
Imported containers?			%
Commodities in stacks?			%
Aircraft?			%
ships (de-ratting etc.)?			%
Artefacts?			%
soil?			%
Others - specify:			%
			%

*** specify the quantity in kg or as a percentage of the total used**
**** where appropriate specify numbers of buildings, containers etc. fumigated and the dosage rate**

What are the most important commodities in stack you treat?

Commodity	tonnes treated in 1997
Cocoa	
Rice	
Dried fruit and nuts	
Coffee	
Others - specify:	

Add any comments you wish to make on the above figures here:_____

_____

_____

_____

What do you envisage will be the most important impacts of the planned phase-out - *use additional paper if you wish*:

(a) on your company?_____

_____

_____

_____

(b) on the economy at large?_____

_____

_____

_____

_____

Please comment on alternatives to methyl bromide fumigation, indicating practicalities and, where possible, relative costs.

_____

_____

_____

_____

_____

Have you any further comments?_____

_____

_____

_____

_____

_____

_____

Signature:_____**Date:**_____

AIDE-MEMOIRE - SERVICE COMPANIES

Details of respondent - name:
position:
company:
address:

Their business:
What is their main business activities
Percentage breakdown of turnover
% from fumigation
overall turnover?

Which fumigants used?
What % Methyl bromide?

How is Methyl bromide used?
For structures - plants
- airplanes
- ships
For commodities - per commodity

Quantitative breakdown

In each use, what will be the impact of the phase-out:

trace the chain of consequences for more important structures and commodities
what type of costs
levels of cost
impact on different types of firms

Who are other important players in the fumigation business?

Appendix 4. Pest control companies contacted during the study

Advance Fumigation & Pest Control Ltd.
Airline Services
Alternative Pest Control
Brian W Coleman Fumigation Services
Check Services
Clearwell Pest Control
Command Pest Control Ltd.
Cuthbertson (Fumigation) Ltd.
Dealey & Associates
Duntox Fumigations Ltd.
Elebert Brothers Ltd.
Essex Fumigations Ltd.
Forward Environmental Services Ltd
Global Services
Gaskill Services P/C & Fumigation
Igrox Ltd.
J A Kent (East Midlands) Ltd.
K & S Fumigation Services
Languard Ltd.
Millhouse Fumigation
Mead Soil Sterilisation
National Britannia Ltd.
Pest Destruction Services Group
Pestproof Ltd.
Precision Pest Management Solutions Ltd.
Rentokil Initial Ltd.
RM Services Ltd.
Rothmanns International Tobacco
Tarleton Fumigation
Terminex Peter Cox
Total Pest Control (UK) Ltd.