ECONOMIC APPRAISAL OF OPTIONS FOR EXTENSION OF LEGISLATION ON GM LABELLING

A Final Report for the Food Standards Agency

Prepared by NERA

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EXECUTIVE SUMMARY

The main purpose of the study is for NERA to advise the Food Standards Agency (FSA) on the costs, benefits, risks and uncertainties associated with the four options for the extension of GM labelling on foods that are being considered by the European Commission. At the FSA's request we have also included analysis of a fifth option. The options are:

- the status quo (**Option A**);
- maintain the status quo and introduce a "GM-free" scheme (**Option B**);
- mandatory labelling of all foods derived from GM material (**Option C**);
- mandatory labelling of all foods derived from GM material and introduce a "GM-free" scheme (**Option C+**); and
- labelling of all foods derived with the help of GM material (**Option D**).

NERA have reviewed a large quantity of written material; we have spoken to participants in the sector; and we have undertaken some modelling of the food supply chain to trace through our assumptions about the relationships between the various cost drivers. As far as we are aware this is the first study to attempt an explicit balancing of costs and benefits for alternative GM labelling options. Most of the studies we have seen focus on solely on costs, sometimes only on some elements of cost, and say very little about benefits. Few comment on the practical or enforcement issues that could undermine any potential benefits.

Our approach has been to take a multi-criteria analysis framework for assessing the options and, using existing evidence where available, to show how alternative assumptions affect the outcome in terms of the relative rankings of the options. This approach forces the appraiser to be transparent about all the assumptions and trade-offs inherent in the appraisal. Although our approach is not intended to provide a forecast of future levels of costs and benefits, we believe that our work provides a strong indication of the relative merits of each of the options.

Based on our framework, and on available evidence, we consider that Option B provides the best balance of costs and benefits. The principle reason for this is that our views about the benefits of the options suggest that the extra costs of moving towards the more stringent GM labelling standards in options C through D outweigh the extra benefits that can be achieved. Option B and, to a lesser extent option C+, perform well for two reasons. First, because it is only these options that provide the benefits that can be derived from standardising the definition of "GM-free"; and second, because we believe that they are likely to perform better in terms of restoring public confidence. This is because they provide a choice of a stringent standard for those consumers who wish to purchase goods to that stringent standard and also because they are less likely to send possibly misleading signals about the risks of GM foods to those consumers who legitimately do not currently have a strong aversion to GM food.

Focussing on those aspects of the options which can be quantified in monetary terms, the Table below illustrates the significant increases in NPV costs over 20 years as the GM labelling standards become more stringent. (Non-quantifiable costs and benefits of each option are discussed in Chapters 4 and 6 of the main report). The much higher costs for Options C, C+ and D reflect the much wider range of food products which could be subject to identity preservation costs under these options. We also note that the increased enforcement problems that may be associated with those options - and thus increase the net overall costs -may contribute to undermining any achievable benefits in terms of increased public confidence in the control of GM foods.

Table 1
Base Case Estimates of Quantifiable Net Present Value Costs in the UK (£m)

Option A	Option B	Option C	Option C+	Option D
96	261	725	825	1,594

By testing the sensitivity of this result to changes in some of our assumptions, we have confirmed the robustness of the conclusion that option B provides the best balance of costs and benefits. We also prepared alternative scenarios - including one that shows the changes in assumptions necessary for Option C+ to become the highest-ranked option.

Option C+ is more likely to be the better option if it performs better than Option B in restoring public confidence, and if the nutritional and/or agricultural productivity benefits of greater market penetration of GM foods are high. However, our judgement is that Option B is likely to perform better that Option C+ in terms of restoring public confidence. We also note that our estimates of costs are more likely to be underestimates than over-estimates, and any increases in costs lead to Option C+ looking even less attractive relative to Option B.

Our assessment is that the impacts of the costs of identity preservation on food prices for final consumers will be relatively low, largely because these costs only form a small part of total costs for food production and distribution. Although high-income households will face the highest price rises, low income households will face a higher proportion of the price rise under the higher cost options than they do under the lower cost options. The impact on small businesses is much more difficult to assess, but the combination of high identity preservation costs and a large number of small businesses may lead to a particularly adverse impact in the bread and cereal food manufacturing sector, which may adversely affect consumer choice.

The assessment of costs and benefits carried out in this study is based on the assumptions that the proposals are enforceable, that they will contribute to restoring consumer confidence and that there will be no major trade implication that could cause further consumer mistrust or welfare losses through more restricted choice. Successful enforcement may depend on consistent implementation across Europe, with agreed thresholds, detection methods and enforcement regimes. Without this consistency, consumer confidence in GM foods may fall further due to the relatively high potential for fraud.

1. INTRODUCTION

This final report forms part of the agreed outputs under a contract between NERA UK Ltd (NERA) and the Food Standards Agency (FSA). An interim report was submitted to the FSA in March.

The main purpose of the study is for NERA to advise the FSA on the costs, benefits, risks and uncertainties associated with the four options for the extension of GM labelling on foods that are being considered by the European Commission.[1] At the FSA's request we have also included analysis of a fifth option. NERA have reviewed a large quantity of written material; we have spoken to participants in the sector; and we have undertaken some modelling of the food supply chain to trace through our assumptions about the relationships between the various cost items. As far as we are aware this is the first study to attempt an explicit balancing of costs and benefits for alternative GM labelling options. Most of the studies we have seen focus solely on costs, sometimes only some elements of cost, and say very little about benefits.

This report is structured as follows:

- In Chapter 2 we set out our understanding of the nature of the four labelling options.
- In Chapter 3 we provide some background on the debate on GM foods in the UK, including a discussion of the costs and benefits of genetic modification of foods and a review of the rationale for GM labelling of foods.
- In Chapter 4 we discuss the types of costs and benefits that arise from GM labelling.
- In Chapter 5 we show how we have quantified the costs of the options, both identity preservation costs and enforcement costs.
- In Chapter 6 we show the balance of costs and benefits for each of the options using multi-criteria analysis and describe our assumptions for quantifying benefits. We also test the sensitivity of the results to a wide range of assumptions.
- In Chapter 7 we assess the way in which the option costs are distributed across household categories and how they impact on small businesses.
- In Chapter 8 we draw conclusions from our results and suggest the further work that could be undertaken in order to improve the robustness of the analysis.
- Appendices provide the terms of reference for this study, discussion of cost estimates from other studies, the structure of the food industry and a bibliography.

[1] The terms of reference for this study are included in Annex A.

2. THE LABELLING OPTIONS

Box 2.1
Summary of Chapter 2: The Labelling Options

In this Chapter we outline our understanding of the four options (A, B, C and D) that have been put forward by the European Commission, based on document ENV/620/2000 (a working document on the traceability and labelling of GM material and products derived from GM material). At the request of the FSA we have also considered a further option – Option C+.

The options are:

- the status quo (**Option A**);
- maintain the status quo and introduce a "GM-free" scheme (**Option B**);
- mandatory labelling of all foods derived from GM material (**Option C**);
- mandatory labelling of all foods derived from GM material and introduce a "GM-free" scheme (**Option C+**);
- labelling of all foods derived with the help of GM material (**Option D**).

Options A, C and D require the mandatory labelling of GM foods but build on one another with each delivering sequentially wider definitions of GM content. Under Options B and C+, a GM-free label is introduced (including a definition of what constitutes GM-free).

In all of the options, the Commission will need to specify thresholds for determining whether a product contains GM material. Currently, thresholds are in place for determining whether the presence of GM material is adventitious,[2] but it is unclear whether these thresholds will change under any of the options. The lower this threshold, the higher the costs of segregation because stricter safeguards must be in place to avoid adventitious contamination. We discuss thresholds in more detail below, but our understanding to date is that costs rise very significantly as thresholds fall.

Under all the Options, we assume that the Commission set labelling requirements as Regulations, but that enforcement and monitoring will require national legislation and be the responsibility of individual member states.

[2] Adventitious implies that the presence of GM material is accidental.

2.1. Option A - The Status Quo

Under current legislation,[3] food products must be labelled where GM DNA or protein is present in the final product. Products in which the presence of GM DNA or protein of in ingredients of the final product is adventitious and less than one per cent are excluded. (One per cent is generally agreed to be the threshold for reliable testing, although in many cases the presence of GM material below this level can, in principle, be detected.)

This labelling system can be enforced through sampling and laboratory testing. Operators wishing to make use of the one per cent threshold must be in a position to supply evidence to satisfy the competent authorities that they have taken appropriate steps to avoid GM sources. An Identity Preservation (IP) system is one way of providing this evidence.

It is as yet unclear how the legislation would respond to changes in the detectability of GM foodstuffs. We understand that some advances in testing have been made and that it is possible to test for the presence of GM protein below the one per cent threshold, particularly if testers have prior knowledge of the type of protein that they are testing for.

Our understanding of current labelling requirements is that enforcement is the responsibility of individual member states. In the UK, we are not aware of testing regimes or protocols that are set at the national level. Testing is undertaken locally (e.g. through the Trading Standards Officer) and by lobby groups such as Friends of the Earth, rather than through structured testing programmes.

2.2. Option B - Maintain the Status Quo and Introduce a "GM-Free" Scheme

Under this option, a voluntary scheme would be introduced where a "GM-free" label indicates that gene technology has not been used anywhere in the production of a particular food product. This would run in parallel to the current scheme (Option A). It is voluntary in the sense that only those wishing to claim that their product is GM-free would need to label. The aim is to provide a common definition of what constitutes GM-free.

The GM-free label would indicate that "gene technology has not been used anywhere in the production of a particular food product". In principle, this would mean that meat, milk or eggs from animals fed on GM feed would not be counted as GM-free, nor would foods manufactured using processing aids (such as enzymes) derived from GM source organisms. This boundary appears to be the same as that implied in Option D, although in Option B it is applied to identify GM-free products and is voluntary.

[3] Current regulations governing the labelling of GM foods are the EC Novel Foods Regulation 258/97 and Regulation 1139/98 covering the labelling of soya and maize, as amended by regulations 49/2000 and 50/2000.

Certification for this scheme would have to be based on a paper trail guaranteeing product integrity.

This option has parallels with labelling organic foods. EU legislation on organic food production already excludes the use of GM materials or their derivatives (including processing aids) on a very strict basis. The cost implications are likely to be less than those for organic foods, however, as products labelled GM-free would not have to meet the additional conditions required to qualify as organic.

It is as yet unclear what kind of thresholds might apply when the presence of GM materials are adventitious and how such a threshold might be defined. These may remain as currently defined. We assume that a zero threshold would apply if the presence of GM materials were not adventitious.

2.3. Option C - Mandatory Labelling of All Foods Derived from GM Material

This option requires mandatory labelling of all food, food ingredients, additives and flavours that contain or are directly derived from GM material. It would require labelling of all those products labelled under Option A, plus all other products derived directly from GM commodities, irrespective of whether there are traces of modified DNA or protein present in the final product which would show up in a laboratory test. Therefore any intermediary products that feed into the final product would need to be labelled as GM.

Enforcement would rely on a comprehensive paper trail, in contrast to Option A, and could not be wholly monitored through sampling and laboratory testing. It is as yet unclear what kind of thresholds might apply when the presence of GM materials are adventitious and how such a threshold might be defined. These may remain as currently defined. Presumably a zero threshold would apply if the presence of GM materials were not adventitious.

2.4. Option C+ - Option C and Introduce a "GM-Free" Scheme

We have introduced this option at the FSA's request. It is very similar to Option B in structure as it includes exactly the same "GM-free" scheme but combines it with the Option C labelling standard rather than with the Option A standard.

2.5. Option D - Labelling All Foods Derived with the Help of GM Material

This builds on option C, but also requires the labelling of foods that use GM processing aids and meat, milk and eggs derived from animals fed on GM feed. Processing aids are not considered to be ingredients as, by definition, they have no technological effect in the final foodstuff. Examples include chymosin (or rennin) which is used in cheese-making in order to curdle milk. Traditionally calf rennet was used, but now up to 90 per cent of hard cheese is manufactured using a GM alternative.

Enforcement would be similar to that required for Option C but the paper trail would need to go back further (e.g. to trace sources of animal feeds) and would be wider in the sense that processing aids, which do not appear in the final product but are used in the manufacturing of the product, would also have to be monitored. It is unclear what kind of thresholds might apply when the presence of GM materials are adventitious and how such a threshold might be defined. These may remain as currently defined. Again, we assume that a zero threshold would apply if the presence of GM materials were not adventitious.

3. BACKGROUND TO THE APPRAISAL

Box 3.1
Summary of Chapter 3: Background to the Appraisal

In this Chapter we discuss some background issues that are important for the understanding of the costs and benefits of GM labelling. In particular, we aim to be clear about the distinction between the costs and benefits of genetically modifying foods and the costs and benefits of labelling for the GM content of foods. To this end we discuss the following issues.

- First, we describe the costs and benefits of genetically modifying foods. There has been a fierce debate about the potential costs and benefits of GM. The main potential benefits for GM foods include the scope for improvements in yield, improvements in food quality and environmental benefits in the from of reduced use of pesticides and fertilisers. The main potential costs include uncertainty about possible human health impacts and concerns about possible environmental impacts including gene transfer, increased herbicide use and loss of biodiversity.
- Second, we discuss the views of consumers, consumer groups and environmental lobby groups. Both environmental and consumer lobby groups in the UK tend to be strongly opposed to the further development of GM foods on ethical grounds as well as in response to perceptions about risks to human health and the environment. Evidence on the views of consumers is less clear, though there does seem to be some consumer unease about GM foods and clear support for GM labelling.
- Finally, we discuss the rationale for GM labelling in the light of views on the advantages and disadvantages of GM foods. There are a number of drivers for GM labelling, including the signalling to consumers of "desirable" characteristics such as the GM-free labels and the signalling of "undesirable" characteristics such as GM labels.

3.1. Costs and Benefits of Genetic Modification

It is important to be clear from the outset that the appraisal we are undertaking is not an appraisal of the costs and benefits of using genetic modification in the agri-food industry. It is an appraisal of the costs and benefits of alternative requirements for labelling food products for their GM, or absence of GM, content. Nevertheless, it is useful for us to note here that there has been a great deal of controversy in the UK, and elsewhere, over the use of GMOs in the food chain. We outline below some of the main elements of the arguments that have been presented for and against the use of GMOs. These arguments are important for an understanding of the costs and, in particular, the benefits of GM labelling, both of which are discussed in more detail later in this Chapter.

The Government's position has been usefully summarised by Dr Jack Cunningham, then Minister for the Cabinet Office:[4]

> "*The Government believes that the protection of human health must be the first priority in regulating biotechnology. The impact on the environment and on biodiversity must also be thoroughly assessed, and the ethical issues raised by biotechnology fully taken into account. At the same time, the Government believes that this technology has the potential to offer enormous opportunities for improving the competitiveness of the economy and the quality of life in terms of health, agriculture, food and environmental protection, and that regulation should facilitate technological development by not imposing unjustified burdens on the biotechnology industry…*"

The benefits from genetic modification that have been suggested include those listed below. For the most part they are very uncertain. Some may have little potential (or may cause harm). Others may lead to huge changes in the way that food is produced.

3.1.1. Potential benefits from GM foods

- **Improvements in yield and flexibility**: Measures of this kind reduce the unit costs of food production, by increasing yields reducing production costs and improving flexibility of crop management. They include herbicide and pest resistance, greater resilience (e.g. to frost), marker genes to identify disease at an earlier stage, increasing milk yields and slower ripening and decay.

- **Improvements in food quality**: These include improvements in nutritional value, reduction in allergens, improvements in taste and convenience (e.g. seedless watermelon, soft stemmed broccoli), and potatoes which absorb less fat, together with benefits from production changes such as less spraying.

- **Environmental benefits**: GM crops offer the potential for less, and less frequent spraying, with more degradable herbicides, less fertiliser, less land under cultivation, more natural growth on agricultural land, and more insect life.

- **More productive and useful industrial crops**: GM offers improved efficiency and quality of production of chemicals already extracted from plants (e.g. starch from potatoes, paper pulp from trees). There is potential for advances in the production of fuel, pharmaceuticals and chemical raw materials.

- **Specific benefits to the developing world**: It is widely argued that, given supporting aid to finance it, GM can be of exceptional benefit to developing countries, especially in areas such as pest resistance, greater resilience to climatic range, or to salt or drought, and in slower ripening. (The OECD report that world

[4] Quoted by House of Commons Select Committee on Environmental Audit (1999).

crop loss due to insect infestation alone is 15 to 20 per cent, and far higher in developing countries.)

At present the main genetic modifications that have cleared regulatory hurdles for products sold in the UK are for herbicide tolerant traits (soya beans and maize) and for insect resistant traits (maize).

3.1.2. Potential costs of developing GM foods

The main cost issues that have been raised in the debate on GM foods are listed below.[5]

3.1.3. Potential human health costs

- **Toxicity and Allergic Reactions**. This is the possibility that GM food could inadvertently contain proteins which are toxic to humans or which cause allergic reactions.
- **Antibiotic Resistance**. There are two main concerns here arising from the presence of antibiotic resistant genes in some GM foods – that bacteria in the human gut could become resistant to antibiotics and spread that resistance to other bacteria, and that the presence of these genes in GM food could affect the performance of antibiotics used in medical treatment.
- **Unintentional Changes**. The imprecise nature of some GM techniques may result in unintended impacts on the plant's characteristics, which might be harmful to humans.
- **Transfer of novel genetic material to the consumer**. There is some concern that "manufactured" gene sequences could be transferred to consumers with unknown consequences.

3.1.4. Potential environmental costs

- **Gene transfer**. There is a possibility that modified genes may be transferred from crops to other species of plants or to micro-organisms in the soil. The latter is believed to be unlikely though there is clear evidence that modified genes can, in some circumstances, be transferred to other plant species.[6] The extent to which this may be harmful depends on which characteristics are transferred to which plant species. The spread of genes responsible for herbicide tolerance to non-target plant species, for example, could clearly be damaging.

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5 We draw here on the discussion in Parliamentary Office of Science and Technology (1998).

6 Parliamentary Office of Science and Technology (1998).

- **Competition with non-GM crops**. Some are concerned that beneficial characteristics in GM crops might lead those crop plants to spread and start to compete with wild species, becoming a pest.

- **Pest resistance**. There is already evidence that some insect species have evolved to become resistant to plants that are genetically modified for insect resistance through the introduction of a gene that enables production of the Bt toxin.

- **Impact on herbicide use**. Environmental groups believe that the use of herbicide resistant GM crops will encourage more widespread use of herbicides which, in turn, could have damaging environmental effects. The companies developing these GM crops have argued, however, that they will lead to reductions in herbicide use.

- **Biodiversity**. There are fears that some of the impacts noted above could lead to wider impacts on levels of biodiversity if, for example, widespread use of insect resistant GM varieties led to reductions in the numbers of insects and insect species then this would have other impacts on the ecosystem including impacts on bird populations and on other species that interact in some way with these insect species.

3.2. The Views of Consumers and Environmental Groups

Although, as far as we are aware, there is not any current scientific evidence that suggests that genetic modification of foods has caused or is likely to cause harm to the environment or to human health, these concerns have struck home strongly with the media and with consumer lobbies.[7] In response to the consequent outcry, most major supermarket groups in the UK are phasing out the use of GM ingredients in their own brand labels.

The House of Commons Select Committee on Agriculture commented on the position as follows:[8]

> *"The first consumer product to reach the shops was tomato paste, launched with a proper education campaign, rewarded with satisfactory sales but withdrawn in the wake of panic whipped up by campaigns against "Frankenstein foods". The supermarket chains responded with radical action to root out genetically modified ingredients in order to reassure and thereby keep their customers. Few organisations emerged from this with much credit, not excepting the Government, which was at first supportive of genetically modified foods but then was forced into reviewing both attitudes and statutory approval procedures in the face of the public and media panic. We believe that it is vital that this confusion is now replaced by rational debate and education in order that the market can serve those who actively choose to grow or consume genetically modified foods as well as those who choose not to do so."*

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7 See Donaldson and May (1999) for a discussion of the human health issues and evidence.

8 House of Commons Select Committee on Agriculture (2000) The Segregation of Genetically Modified Foods, paragraph 1.

As noted above, consumer and environmental groups such as Greenpeace, Friends of the Earth and the Consumers' Association have been very vocal about their apprehensions regarding GMOs and in their demands for strong labelling regulation. Their main concerns have been about the potential human health impacts, environmental impacts, ethical and moral issues and consumer choice. They also question the degree to which the proposed benefits are achievable.[9] As an illustration of the views of consumer and environmental lobby groups we briefly summarise the approach of Greenpeace, Friends of the Earth and the Consumers' Association below.[10] This summary is based on information on their websites and other sources such as their submissions to Parliamentary Select Committee Inquiries. We have not spoken to representatives of any of these groups.

3.2.1. Friends of the Earth (FOE)

FOE's food and agricultural campaign started two decades ago. In recent years the primary focus of the campaign has been on issues related to GM foods and crops in the UK in the wake of rapid introduction of these products into the UK. The organisation is largely concerned with preservation of the identity of non-GM foods and protection of the environment from the known and unknown risks that may arise due to genetic engineering.

Together with 90 other social and environmental organisations FOE has called for a *Five Year Freeze* campaign which calls for a minimum five year moratorium on the growing and import of GM foods and farm crops, and on the patenting of genetic resources for food and farm crops. Other suggestions outlined in their campaign aim include public consultation on all genetic modification trials and experiments, and a global ban on the use of gene technology which prevents seeds germinating (the so called terminator technology).

To preserve the identity of non-GM foods, FOE suggests increased segregation of GM and non-GM products; better isolation of GM from non-GM crops; and a comprehensive auditing and labelling system that enjoys public support. It suggests that the cost of ensuring this distinction between GM and non-GM products should fall upon the GM industry and therefore that there should be a levy on biotechnology firms that should finance the cost of undertaking these operations.

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9 See, for example, Dibb and Mayer (2000).

10 This represents only a very small sample of the lobby groups active in this area.

3.2.2. Greenpeace

Greenpeace has been campaigning against the release of GMOs into the environment for almost a decade. Like FOE, Greenpeace also considers segregation to be very important, even with the present labelling laws, to ensure that people have genuine access to alternatives to GM products.

Greenpeace has suggested a detailed procedure for labelling of GM foods in the European Union. Under this scheme all food products that have been produced, processed, grown or cultivated with GMOs or with products that have come in contact with GMOs should clearly be labelled. This would encompass looking at the complete chain of production and all components of the final product. Moreover, it suggests that liability for any health affects caused from food products derived from GMOs should be the responsibility of the food processing company involved, thereby making these companies more cautious in using GM material in food products.

Greenpeace considers these labelling requirements necessary to give consumers a satisfactory choice between non-GM and GM food. Besides GM food, Greenpeace also campaigns against the patenting of plants and their genes and argues for a *Biosafety protocol* that would control cross-border transportation, handling and uses of any genetically engineered organism that may have adverse effects on the conservation and sustainable use of biological diversity.

3.2.3. Consumers' Association (CA)

CA is an independent consumer organisation with over 700,000 members in 1999. It has conducted research on several aspects of GM foods in the UK market through surveys and focus groups to assess consumer attitudes towards GM. It publishes *Which?* and *Health Which?* magazines. It suggests that though there are benefits of GM foods, more research is required to find out about the unknown long-term possible risks associated with GM. Until the time when consumers can feel comfortable with the technology, it suggests that the industry should be closely monitored and regulated.

Based on its surveys, CA believes that people feel very strongly about the GM related issues. It has campaigned for effective labelling and segregation of GM products so that consumers have the knowledge about the content of the food that they consume. To meet this requirement it calls for complete traceability of products throughout the food chain. In terms of labelling, in contrast to present EU regulation, it suggests that product labelling should reflect the entire manufacturing process and not just the content of the final product.

CA has called for regulating the system on the basis of identity preservation (IP) through the food chain. This would entail clear segregation of GM and non-GM products. CA believes that such an exercise would be practically feasible because in recent years non-GM supplies have become available to meet the demand in Europe, without increasing the price of food to consumers.

CA also calls for a lowering of the threshold level of accidental contamination that is permitted to as low as is practically possible before phasing it out when non-GM supplies become available. This they believe is important so that there is an incentive for producers to keep GMOs out of non-GM foods as much as possible.

3.2.4. Evidence from consumer surveys

The evidence from surveys of consumer views of the use of GM foods in general and on issues relating to labelling more specifically is mixed, perhaps in response to the way questions are phrased, although there is evidence of some consumer unease about GM and there is clear support for labelling. The evidence we have seen is not sufficient to further distinguish between levels of customer support for each the five labelling options we are considering.

In the MORI study for the FSA of September 2000 the strongest concern about food information related unsurprisingly to allergens, but GM, along with animal welfare and nutritional content was also significant. People also reported lack of faith in the accuracy of GM labelling and many people believed that it was already compulsory. The idea of standard labels for qualities such as vegetarian (V), gluten free (G), dairy free (D) and GM free (GM) was attractive. A third of the sample of interviewees recorded GM as one of the key things about food products which people would like to know. This could suggest that a stronger system for identifying whether a product has or has not a GM content would be consistent with consumer preferences.

The study for the FSA of January 2001 on consumer information needs also revealed a fairly strong demand for information on whether food had a GM content. 25 per cent of people said they looked for GM information on food labels, 43 per cent reported concern about GM and a surprisingly high proportion of 72 per cent said that GM affected their eating habits. Again, the information people appeared to want was of whether the food was or was not in some undefined sense “GM”.

A survey on attitudes to biotechnology was undertaken in 2000 on behalf of the European Commission.[11] As part of that survey, respondents were presented with a number of statements about GM foods and asked about the strength of their agreement with the statements. It is noticeable that across the European Union there was most agreement with the statements that tended to present GM foods in a negative light and least agreement with statements that tended to present GM foods in a more positive light.

[11] European Commission (2000).

The Institute of Grocery Distribution (IGD)[12] produced a report in 1999 on GM foods which includes surveys of consumer attitudes. The IGD website records two main results of the consumer survey, which was carried out in March 1999. In response to the question "To what extent are you concerned about the safety of eating GM ingredients from genetically modified crops?", 23 per cent of respondents were very concerned and 28 per cent were fairly concerned. The remainder (49 per cent) had no strong views or were not concerned. In response to the question "What effect do you think genetic modification will have on the environment?" 21 per cent of respondents said a fairly negative effect, 17 per cent said a very negative effect and the remainder (62 per cent) thought the effect would be positive or had no strong views.

A Consumers' Association survey in 1999 found that 90 per cent percent of the respondents had heard of genetic modification. Of these 94 per cent felt that there should be clear labelling on food packaging and 92 per cent agreed that food ingredients that come from a GM plant but cannot be detected in the final product should be clearly labelled.

3.3. The Rationale for GM Labelling

One requirement for markets to work efficiently is that consumers should be well informed about what they might buy. Using this information they can, in principle, buy the range of goods and services which gives them the most benefit from their personal budget. Suppliers of goods and services respond to these demands by competing to develop attractive new products and reducing their production costs as far as they can.

In practice, of course, there are very many factors which prevent such an ideal. But by and large the system works – and information is an essential driver.

We characterise product labels as being of two types: those that advertise desirable product characteristics to consumers, and those that warn consumers of characteristics which they might wish to avoid.

3.3.1. Labelling for desirable characteristics

Where desirable product characteristics are not immediately obvious to consumers, producers have a strong incentive to signal those characteristics by labelling their products.[13] In the food sector, labelling foods as "low fat" is one example of this, where manufacturers are aiming their products at the health conscious segment of the market. Those consumers who wish to reduce the levels of fat in their diets will tend to choose those products that manufacturers have helpfully labelled as "low fat".

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[12] The IGD claims to be the only organisation in the world that has members from all parts of the food and grocery market – retailers, caterers, wholesalers, manufacturers and farmers, plus packaging companies and those that service and comment on the industry such as consumer groups.

[13] Other mechanisms, such as television advertising are also used for these purposes.

In these circumstances, however, several factors can combine to reduce the value of this information to consumers. Since a number of manufacturers are likely to be competing to sell their products to this segment of the market, they will all be selling products that are labelled as "low fat" or some similar claim such as "low cholesterol". There is an information asymmetry here, as manufacturers will know what they mean by their own labels but consumers are unlikely to know how the different manufacturers' definitions of "low fat" vary. Since consumers cannot usually directly see or test for themselves the exact meaning of manufacturers' claims, or indeed be able to tell whether these claims are true, consumers may not make much use of the labelling information. In these circumstance both the consumers and the food manufacturers lose out.

The main response to this type of problem has been to standardise labelling information. Sometimes the producers act voluntarily to standardise information – this is how the "organic" food label originated. Frequently, however, this is followed by legally enforced standards. These may be seen as necessary because of the difficulties inherent in reaching agreements about standards across large numbers of producers, particularly where international standardisation is desirable, or because government intervention and enforcement provides more assurance to customers that standards are likely to be adhered to.

3.3.2. Labelling for undesirable characteristics

Many products are labelled to warn consumers of undesirable characteristics. Examples include health warnings on cigarette packets, fire hazard warnings on some clothes and soft furnishings and warnings about the dangers of using fireworks. Food products may contain warnings of allergens. Processed food labels list ingredients including some, such as fats, which people may wish to control.

The incentives for producers to voluntarily warn consumers of product characteristics such as these is less clear than it is for desirable product characteristics. Even so, most responsible producers would see this as an important role for product labelling, not least because of the potential for adverse publicity and legal action if products are not labelled with adequate warnings. For most products where there are possible dangers, there are strict legally enforceable labelling requirements in order to correct for this information asymmetry problem. This approach provides the maximum assurance to consumers.

3.3.3. Labelling for GM content

In our discussion above, we mention the information asymmetry problem as a reason for government intervention to set labelling standards in food markets, in relation to both desirable and undesirable product characteristics. Information asymmetry is one of the many practical examples of "market failure". Market failures are situations where markets

are not functioning in a way that maximises social welfare and it is generally considered to be the main rationale for government intervention in markets.[14]

The options for GM labelling that we are assessing seem to be aimed at two concerns about asymmetric information.

One concern is for an indicator of what some consumers will view as an undesirable characteristic - Options A, C and D fall into the category. The aim is that consumers should have available to them clear and consistent information about when a product has GM content (or where the production process has involved the use of GM material). For those consumers who had no *a priori* view that GM content was undesirable, the fact of labelling in this way may lead some of them to believe that GM content is undesirable, or at least to assume that the Government believes that there may be some dangers associated with foods that have GM content.

The second concern is for an indicator of what some consumers will view as a desirable characteristic - Options B and C+ fall into this category. The aim is that the needs of those consumers that see absence of GM content in a product and no use of GM material in the production process as desirable characteristics, should be catered for through the introduction of a standardised "GM-free" label.[15] For the most part there is unlikely to be a need to label GM foods as a signal of desirable characteristics because the desirable characteristics that are available through GM are likely to manifest themselves in other ways such as through lower prices or better texture or ripening characteristics.[16]

The main reason for some consumers wanting this information is the uncertainties about the long term effects of consumption and production of GM foods. An appropriate policy response in this type of situation is to ensure that as much information as possible is available (in addition to labelling) to enable consumers to judge whether sufficient research and regulation is being undertaken. The "precautionary approach", a much used term in environmental policy, is a response to imperfect information.

Another example of market failure is "externalities".

An externality is a cost or a benefit that does not directly affect the person taking a production or consumption decision, even though society as a whole would be better off if they were taken into account. In the GM context one example of a possible externality is that

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[14] Government intervention can take many forms of, usually, regulation, public expenditure or taxation.

[15] We note that Option D would also enable these customers to choose food products with these characteristics - in this case, all products that do not have a GM label. However, the GM–free label is likely to provide a clearer and firmer signal to consumers of the absence of GM material, and allows producers to advertise this characteristic in a positive way.

[16] In future, however, if GM foods become much more widely accepted by consumers, it is easy to envisage producers using the GM label as a positive selling point since it could be seen as a proxy for some of the benefits of some forms of GM that are less obvious at the point of purchase, eg taste.

a consumer may purchase a GM product because it has a lower cost to them, without taking account of the potential cost to the environment of producing GM foods.[17] Of course imperfect information is also a problem here because the environmental impacts are uncertain. Appropriate policy responses to externalities vary, but in the example above the licensing of GM crops before they are grown would be one response. This type of externality is relevant to the GM labelling question because the aim of the more stringent labelling options, and in particular of Option D, seems to be to provide information to consumers who are not principally concerned about the possible direct impacts on their own health but about wider issues such as environmental impacts and ethical questions. This appears to be the case because the extra foods that would need to be labelled as GM under Option D, and to a lesser extent Option C, are much less likely to be associated with the consumption of GM material than products labelled as GM under Option A.

We also note that there are hopes that changes to the current labelling regime (option A) will lead to a restoration of consumer confidence in the control of GM foods. The European Commission, for example sees changes to labelling regulations as part of a package of measures which would contribute to restoring public confidence. In announcing this package the Commission made the following statement:[18]

> "*The European Commission decided yesterday to propose to Member States a strategy to regain public trust in the approval procedure for Genetically Modified Organisms (GMOs). The objective is to resume the authorisation process for GMOs in the near future whilst addressing public concerns on GMOs as well as problems of legal uncertainty for stakeholders. The Commission wants to give a clear response to political and legal concerns over GMOs which favours consumer choice and legal certainty…..*"

The Environment Commissioner, Margot Wallstrom also stated:[19]

"*We need to re-establish confidence in our approval systems. Citizens must be allowed to choose for themselves whether they want products containing GMOs or not*."

We categorise, in the light of this discussion, the principle potential benefits from GM labelling in the next Chapter.

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[17] Even if the consumer in question does not place any value on the environmental cost, others in society do and so this would still be an externality.

[18] European Commission Directorate-General for Health and Consumer Protection (2000).

[19] Reported in the same press release as above.

4. COSTS AND BENEFITS OF GM LABELLING

Box 4.1
Summary of Chapter 4: Costs and Benefits of GM Labelling

In this Chapter we first introduce our overall approach to the assessment of the options which, given the difficulties in quantifying some of the costs and benefits, is based on multi-criteria analysis. Then we discuss the main potential benefits of GM labelling and the main potential costs of GM labelling.

Benefits

The main potential benefits are:

- standardisation of "GM-free" claims;
- more freedom for consumers to exercise their preferences;
- restoration of consumer confidence, which may lead to longer term benefits of genetic modification in food production;
- contribution to research on the impacts of GM food.

Costs

The main potential costs are:

- identity preservation costs (falling within the food supply chain) including both segregation costs and traceability costs;
- enforcement costs;
- the dilution of labelling information already on food products;
- changes in market structure resulting from the higher proportional costs faced by smaller businesses.

4.1. General Principles

The approach we are using is consistent with HM Treasury's *Green Book* guidance on economic appraisal (and the Cabinet Office guidance on Regulatory Impact Assessment). Within the constraints of time and data availability, this requires definition, quantification and where possible valuation of the costs and benefits of each of the four options, including risks and uncertainties, and any significant distributional impacts and public sector costs.

In preparing our assessment of the costs and benefits of the four options for GMO labelling, we note some significant difficulties:

- First, there is a huge range of products and process to which the proposed labelling schemes could apply, from basic commodities to animal feedstuffs to complex processed consumer products. Many of these products have long, complex supply chains involving many stages. Within the available timescale it has not been possible to examine a wide range of product groups or each stage of production separately – we have needed to rely significantly on averaging across product groups and applying broad assumptions across different product types and processes.
- Second, the readily available data on the types of cost impact and the size of cost impacts across products and across supply chains is limited, with a significant proportion coming from countries outside the EU (the USA in particular). In some cases we have needed to assume that "unit cost" data from other countries are transferable to the UK situation, though in using it to derive aggregate estimates of cost and estimates of distributional impacts we will be able to make use of UK specific data on industry structure and household consumption.
- Third, the markets for these products are complex not only because of the range of products and processes but also because of the complexity of public sector intervention in these markets, both through regulation and through support in the form of agricultural subsidies. This makes examination of how changes in costs feed through to retail prices difficult.

A key output of this report is a comparison of the costs and benefits of the four options. In cases where all costs and benefits can be valued in monetary terms, this can be done simply by subtracting present value costs from benefits to determine net benefits. However, in the case of GM labelling it is not possible to measure even all the costs, let alone all the benefits, in monetary terms, so the results of our appraisal are presented in a Performance Matrix. This summarises and presents the results of our assessment of the relative merits of the four labelling options in tabular form. We also provide advice on how the information in the Performance Matrix can be compared more directly using Scoring and Weighting techniques. Our presentation of the results is consistent with the approach recommended in the recent manual on the application of multi-criteria analysis to government decision-making.[20]

4.2. Benefits of GM Labelling

This section considers four potential benefits of GM labelling.

4.2.1. Standardisation of "GM-free" claims

Government intervention to define and enforce consistent standards for the use of "GM-free" claims on food labels could be beneficial since it would provide consumers with

[20] DETR (2000).

assurance that different producers mean the same thing when they make GM-free claims about their products and assurance that producers have incentives to be honest about their claims (because the Government will monitor and enforce compliance). Naturally, the extent to which this assurance is provided will depend to some extent on the level of enforcement action planned and undertaken by the relevant authorities.

This benefit may be important because there are many food products for which GM-free claims are now made. However, the size of this benefit is also affected by the extent to which consumers are not already satisfied with the labelling regimes used by producers and retailers in the absence of government intervention. We have seen no specific evidence that consumers are dissatisfied with the current approach to GM-free labelling, though the introduction of a government defined and enforced standard would not be at all unusual in the food sector. This already exists, albeit in a slightly different way, for organic foods for example.

One particular benefit that this standardisation may have is that it standardises the GM-free claim at the level of the tight requirements of Option D and thus it enables those consumers who are particularly concerned about environmental impacts and ethical issues to express those preferences by purchasing foods labelled as GM free under this standard.

4.2.2. More freedom for consumers to exercise their preferences

Enabling consumers to better express their preferences for what they see as the "desirable" or "undesirable" characteristics of GM foods would, in principle, contribute to a more efficient functioning of the markets for food products and lead to long term benefits for both consumers and producers.

The two main factors in extending choice to consumers are the range of alternatives available to them and the degree to which those alternatives reflect their preferences. We consider each of these factors in turn.

Option A allows consumers to choose between three different alternatives:

1. foods that contain GM material under the Option A standard (these will be labelled as GM foods);
2. foods which producers have labelled as not containing GM (eg non-GM or GM-free). The standard for the definition of non-GM will vary by producer, and may not be clear to consumers, but will need to comply with general food labelling legislation (eg not misleading); and
3. foods for which no positive or negative claims for GM content are made on the label. These will not contain GM material under the Option A standard but may contain GM material under Option C or Option D standards.

In fact, each of the labelling Options includes a three way choice, though in each case the choice will be different. In Options B and C+ the "GM-free" label will meet a consistent, enforceable standard (the extra benefits from this are considered separately, above); in Options C and C+ foods which contain GM will be labelled under the Option C standard; and in Option D foods which contain GM will be labelled under the Option D standard. Thus, we cannot distinguish between the options in terms of the number of alternatives they provide to consumers.

To what extent does each option provide consumers with the alternatives that reflect their preferences? The option that provides the most benefits in these terms is the one that most closely matches the preferences of most consumers. For example, if the number of consumers that are willing to pay for foods measured by the Option C standard is small compared to the number of consumers willing to pay for foods measured by the Option A standard, then Option B is likely to provide more benefits than Option C+.[21]

The empirical evidence on people's considered preferences that we have seen is all very general and insufficient to provide clear guidance on which option is most likely to match consumer preferences. Indeed it is hard to see how such subtle information can be obtained other than by through sophisticated questionnaires/interviews and/or focus groups conducted by experienced researchers. For this reason, we have not attempted to quantify this benefit in our analysis later in the report. We note only that because Options B and C+ combine the choice of both a clear stringent standard (the GM-free option is defined at Option D levels) and a less stringent standard then in the absence of any further information it might be expected that these two options are more likely to provide a more relevant choice to consumers. However, this effect is likely to be captured through our assessment of the benefits of standardising the definition of "GM-free" (discussed above).

4.2.3. Longer term benefits of genetic modification in food production

This objective appears to be the main political driver within the European Commission. It has two components. One is the effectiveness of the policy option in restoring public confidence, in a way which reopens the door to GM development. The other is the medium and long term benefits which might arise from the consequent more rapid development of genetic modification in the food supply.

Effectiveness in restoring public confidence is a pragmatic judgment. The outcome will depend upon the political climate at the time and the ways in which the policy is communicated.[22] Stricter controls are not necessarily associated with greater confidence. An argument against tightening controls is that these would imply, or seem to confirm, a lack of

[21] Strictly speaking it is the amounts that customers are willing to pay under each option that are important rather than the number of customers.

[22] Clear and balanced communication to the public about the risks and the relevant evidence is likely to be a significant factor in raising levels of public confidence.

scientific confidence, and so give the message that GM foods are inherently dangerous. We offer our own judgement on this balance, but again this is essentially a political judgement about future lobby group and media behaviour, public opinion, and the effects of these on national and EU political decision making.

The benefits, listed below and described in more detail earlier in this Chapter, are for the most part very uncertain. Some may have little potential (or may cause harm). Others may lead to huge benefits.

- **Improvements in yield and flexibility.**
- **Improvements in food quality.**
- **Environmental benefits**.
- **More productive and useful industrial crops**.
- **Specific benefits to the developing world**.

These potential benefits, relative to an absence of GMO development in crop production, are probably extraordinarily large. However many of these benefits for the world as a whole seem likely to be obtained regardless of European policy, as GM development is likely to continue on other continents. The issues for UK policy are the impact on the UK (and the UK's interest in the welfare of developing countries) and the extent to which a stricter European labelling regime would prevent or delay these benefits.

It was suggested to us that there might be little reason to share the apparent hope in the European Commission that stricter labelling would make authorisation of GM development or commercial release any easier. We largely share this scepticism. The rationale, as set out above, is that those opposed to these developments would have less reason for concern if the labelling made it easier for consumers to avoid such products. However the lobby group and wider political opposition to GMOs appears to us to be based not on concern about the finer details of the labelling regime, but on objections to the technology in principle. The labelling regime is seen more as a political weapon with which to attack GM than as an issue which needs to be resolved to make GM more acceptable.

On a pessimistic judgement, tightening labelling regulation, given the existing, still fairly new regime, could be seen as a lobbying success to rally even stronger opposition to GM.

This judgement can best be made by those officials who are in touch with the political views on GM food in the European Member States and the Commission. We give it a positive very small potential impact.

4.2.4. Potential contribution to research on the impacts of GM food

Since the production of GM food is a relatively new process and since there must still be some uncertainty about the impacts of GM food consumption, the form of labelling that is introduced may affect the degree to which the impacts of GM food consumption on human health and the environment can be monitored. The options that provide for more than one standard might be expected to provide more useful information (ie Options B and C+). Nevertheless we understand from the Food Standards Agency that the likelihood of being able to attribute a specific health effect to the consumption of any one ingredient is remote given the difficulties of tracking food products and their consumption and the fact that labels are unlikely to be specific about the nature of the genetic modification used in the product (except insofar as the ingredient that has been modified is specified). For the purposes of our analysis we assume that this potential benefit is insignificant. We therefore do not include it in our performance matrix for comparing the options.

4.3. Costs of GM Labelling

There are a number of categories of cost arising from the introduction of GM labelling. These include the costs of segregation and traceability arising through the food supply chain;[23] the costs to the public authorities of monitoring and enforcing compliance with the GM labelling regulations; costs arising from the trade implications of new regulations of this type; costs arising from possible changes in market structure and costs arising from the dilution of the information already on food labels. Each of these costs are discussed below.

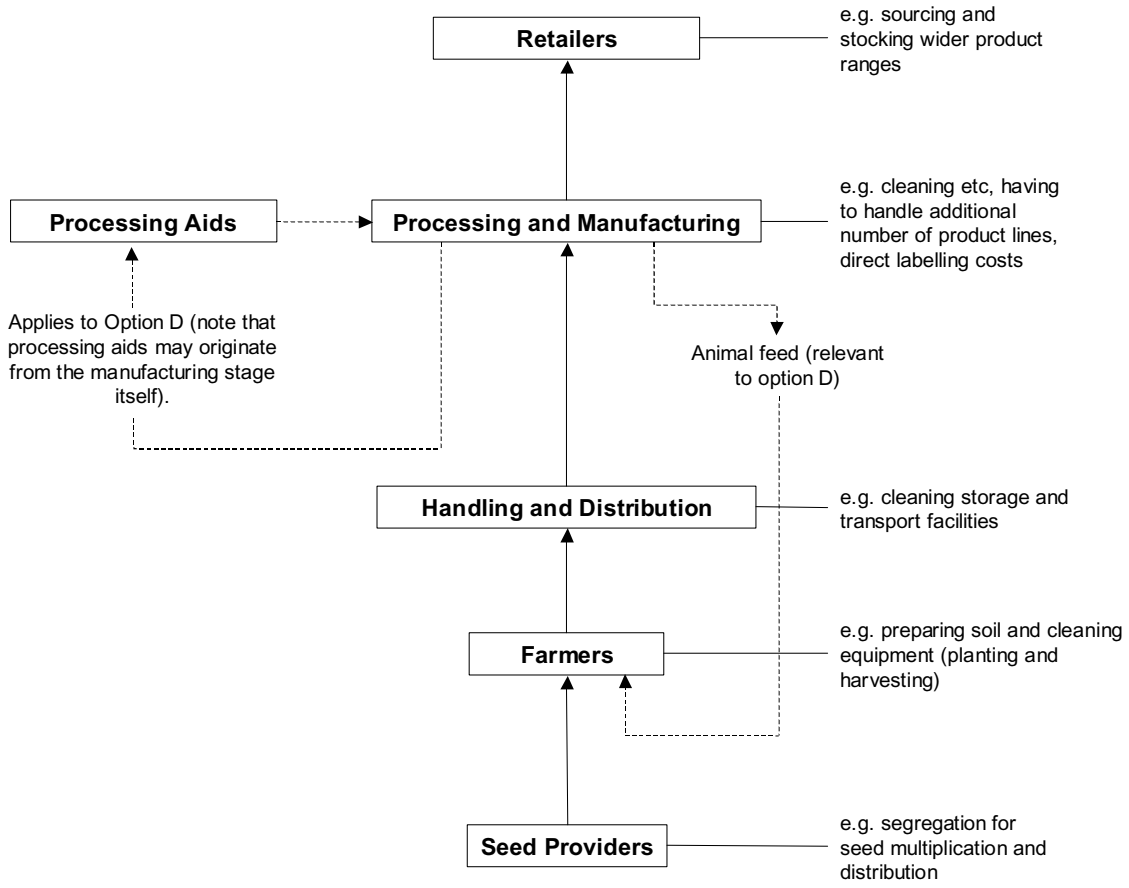
Experience in the UK has shown that even under the current labelling requirements (equivalent to Option A) retailers have gone to considerable lengths to avoid having to label foods as containing GM. To achieve this they have sought to purchase foods and food products that have no GM content. Many have also gone further than this and made claims that their products are non-GM. This has led to the establishment of Identity Preservation systems, with consequent segregation and traceability costs for non-GM food products.

4.3.1. Supply chain costs

Figure 4.1 shows a food supply chain, illustrating examples of how the costs associated with the labelling options fall within the supply chain. The bulk of the costs arise from the need to segregate to prevent contamination of foods that are intended to be GM free (however defined). Many of these costs are common to all the options being considered, but their magnitude will differ under the alternatives. For example, under Option D, the origin of processing aids and animal feed becomes important.

[23] Throughout the report we have aimed to use the term “segregation costs” to refer to the cost of physically separating products, the term “traceability costs” to refer to the costs of systems for documenting the origins and nature of food products, and “identity preservation” or “IP” as a generic term that encompasses both segregation and traceability costs.

Figure 4.1
Segregation Costs are Incurred Throughout the Supply Chain



At all stages, there may be costs associated with transport and distribution, which we do not list separately. It is implicit that, at each stage in the chain, some form of transport is required and segregation may add to the cost of this. The levels at which the costs of segregation fall can be categorised as follows:

- **Seed providers:** To prevent cross-contamination at the seed provision level, minimum distances are required between breeding crops. The current guidelines for certified seed crops are 600m for sugar beet, 200m for maize and 200m for oilseed rape. When seeds are distributed, under segregation they need to be bagged separately. We understand that minimum distances and separate bagging are already common, so we see no need for additional costs at this level under any of the options unless current thresholds are changed.[24]

- **Farmers:** Segregation is required for planting, harvesting and storage at the farm level. During planting, care is needed to ensure that different varieties of seed do not get mixed, fields need to be prepared and cross-pollination must be avoided.

[24] See, for example, Buckwell , Brookes and Bradley (year of study not given).

Planting and harvesting equipment must be cleaned and on-farm storage bins must be cleaned (the degree of cleaning will depend on tolerance levels). These requirements result in down-time, unless dedicated machinery and storage are used. In practice, farms may decide to specialise in dealing with either GM or non-GM crops, thereby removing the need to segregate.

- **Handling and distribution:** The need for segregation of storage and transport facilities could depend on whether grain is known to be destined for animal feed, for food use, or for a combination (segregation of grain destined for animal feed is only required under Option D).

- **Processing and manufacturing:** Again, segregation costs will be associated with the storage and cleaning of equipment, and with the need to run a larger number of production lines (or to do smaller production runs within existing capacity) to deal with both GM and non-GM products. The costs incurred at this stage could differ significantly depending on the labelling option being considered. For example:

  - Under Option C, any GM ingredients added at this stage (whether they contain GM protein or not) need to be segregated and labelled as GM.

  - Under Option D, as above (for Option C) but any product that has been made with GM processing aids or derived from animals fed on GM feed also needs to be segregated and labelled as GM.

  It is likely that the bulk of the costs of segregation and identity preservation (IP) will be incurred at the processing and manufacturing stages.

- **Retailers:** The main costs of segregation at the retail level will be any transport and storage costs associated with having to hold a wider product range (i.e. GM and non-GM lines). In practice, the additional costs are likely to be small under any of the options. It is unlikely that total demand for food will increase under any of the options, but the mix of foods demanded may change and may be spread across a wider range of products.

Under all of the options, segregation is required to ensure that GM foods do not get mixed with non-GM foods. Therefore, there are some common costs under all the options. Where options differ is in what counts as GM. Under Option A, a food is GM if it contains a GM DNA or protein (above a threshold). Under C, a food is GM if it contains any ingredients (including additives) that have been directly derived from GMOs, even if there is no modified protein or DNA in the final product. Under D, foods made with GM processing aids would have to be labelled as GM (processing aids are currently excluded as they have no technological effect on the final foodstuff).

In addition to the costs associated with segregation, Options B, C and D involve a system of traceability. Option A requires segregation to keep the presence of adventitious GMOs below a one per cent threshold, but their presence above this level can be scientifically

tested. Under the other options, traceability is required because labelling standards cannot be verified through scientific analysis alone. Laboratory testing can only identify the presence of GM DNA or protein, but Options B, C, C+ and D have stricter definitions of GM than this. Under Options C and D, traceability applies to all products. Traceability could also exist under Option A as a means of demonstrating that the presence of any GMO protein is adventitious.

Table 4.1 outlines how we believe some of the main costs associated with segregation and IP will differ under each of the labelling options (although this assessment is likely to change as a result of subsequent research and interviews).

When considering the costs under each option, the importance of thresholds for determining when the presence of a GMO is acceptable or can be counted as adventitious is critical. A low threshold implies strict segregation (e.g. thorough cleansing of machinery, storage and transport facilities), which would add significantly to costs.

Table 4.1
How Costs May Vary Under Each Option

Cost	Option A	Option B	Option C	Option D
Traceability	Not required	Required	Required	Required
Seed providers	No significant cost – already have adequate segregation.			
Farmers	Cost depends on whether specialise (in GM or non-GM). Costs will be mainly from downtime whilst cleaning machinery or from soil preparation.			
Handling and distribution	Costs will be incurred under all the options. Their significance will depend on the extent to which handlers specialise. If don't specialise, will be costs of cleaning etc. If known whether output is destined for animal feed, may be able to do longer production runs, minimising downtime.			
Processing & manufacturing	May be significant costs from segregation	Depends on how option is defined and on up-take of GMO-free lines.	Significant costs - more so than Option A because have to ensure all ingredients & flavourings etc are not of GM origin.	Significant costs – more so than Options A or C because have to trace origins of processing aids and range of products affected will be larger. Needs a longer IP trail than under C.
Retailers	Potential cost under all options. Least cost under Option A (or B, depending on how it is defined and on uptake of GM-free lines). Highest cost under Option D (as more products will be affected). Have assumed it to be negligible, however, when compared to other costs.			

In addition to the costs described above, there are set-up, transitional and enforcement costs under all the options except A (retaining the status quo). The options become sequentially more stringent and the set up, transitional and enforcement costs will reflect this. Transitional costs are important. Once labelling legislation has been in force for some time

and consumer demand for different groups of products has become established, producers at each stage in the supply chain may decide to specialise in the production of either GM or non-GM outputs. Others may decide to continue doing both, but if they specialise in this way, the costs of segregation become much less significant. The bulk of the costs may then be in enforcement associated with guaranteeing IP.

There may also be small costs associated with re-designing labels. These are likely to be one-off and relatively small, although there may be some on-going costs because shorter labelling runs are done on a wider range of products.

4.3.2. Enforcement costs

4.3.2.1. A conceptual framework

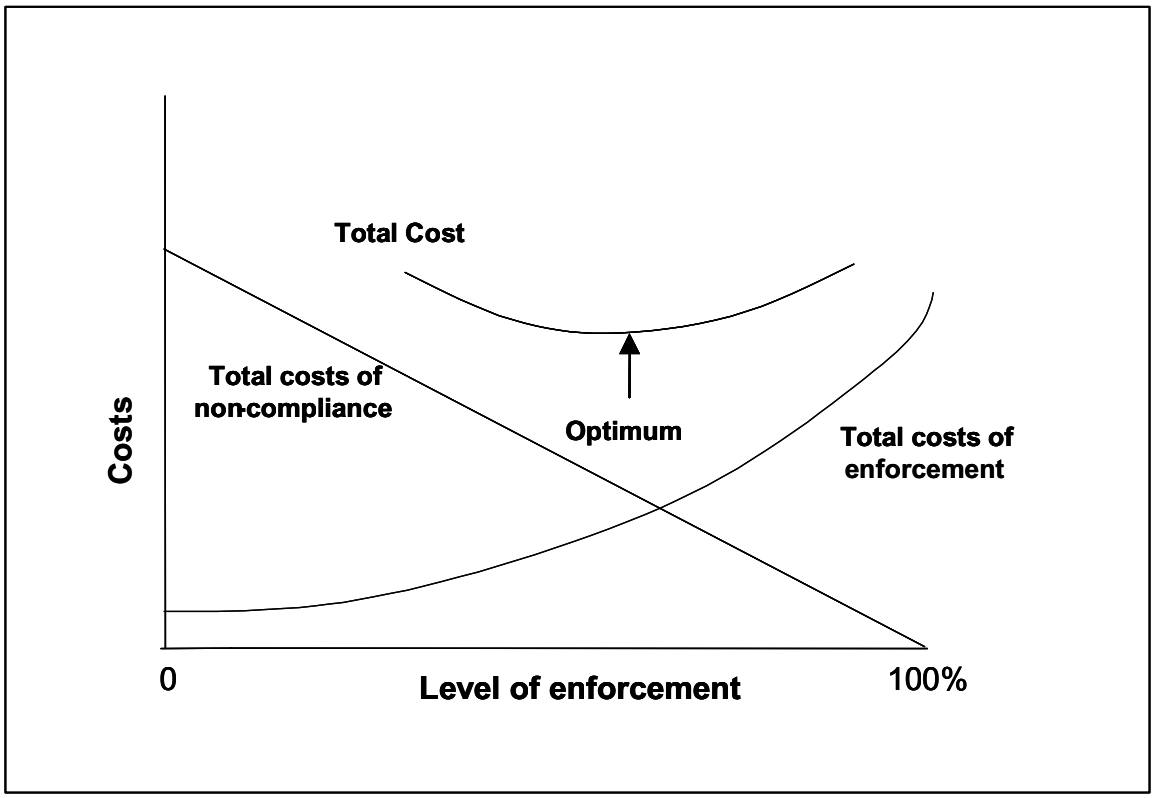
This section sets out briefly the conceptual framework within which the effectiveness of regulatory enforcement systems may be assessed. We then discuss the available evidence on the costs of enforcing the options for GM labelling in this context.

The economic literature covering the theory of law enforcement is substantial.[25] The theoretical framework underlying most of this literature, broadly known as "optimal deterrence theory", encompasses a number of models analysing regulatory arrangements for monitoring and disciplining undesirable behaviour. Different models are based on different assumptions about the objectives of regulation and about the behaviour of the regulator and the regulated, and the results are generally sensitive to the initial assumptions made. It is beyond the scope of this report to summarise this very diverse literature. Instead, we present below a synthesis of the main features of the optimal deterrence framework.

In principle, optimal deterrence occurs when the sum of the costs of non-compliance with the labelling standards on the one hand, and the costs of deterring or preventing it on the other, are minimised. Typically the costs of enforcement are "increasing" -e.g. the cost of deterring the first 10 per cent of potential offenders is less than the extra cost of deterring the last 10 per cent. The costs of non-compliance may be increasing or decreasing or broadly constant. This is illustrated in Figure 4.2, for increasing costs of enforcement and a constant cost of non-compliance.

[25] The seminal work is Becker (1968). Other important contributions are Pyle (1983) and Fenn and Veljanovski (1988).

Figure 4.2
Optimal Deterrence



While this framework is straightforward from a theoretical point of view, measuring and quantifying the costs of enforcement and non-compliance is much more difficult. These costs are discussed in the remainder of this section.

4.3.2.2. The costs of enforcement

The main costs of enforcement are:

- the cost of testing foods for GM content.
- the cost of monitoring the accuracy of traceability mechanisms.
- The cost of imposing penalties for non-compliance.

Since enforcement will be the responsibility of public sector agencies, these costs provide the main scope for public sector costs for the four labelling options.

There may also be more indirect effects on the Exchequer from other aspects of the GM labelling regime, through the impact of labelling on the longer term development of the industry and the consequential effects on the system of agricultural subsidies and import duties. Whilst we discuss the potential impact of GM labelling on the longer term

development of the industry elsewhere in this report, we do not develop further any estimates of these consequential Exchequer impacts.

Under the current regime (ie Option A) the Local Authority Trading Standards Officers (TSOs) are responsible for monitoring and enforcing compliance with food labelling requirements (including GM labelling) in their own areas. TSOs undertake regular and routine inspections of companies operating in the food industry at all levels of the supply chain. The frequency of inspection is based on a number of factors including the level of public concern about an issue, the level of political pressure and a risk assessment which takes into account the nature of the business and products, and previous performance of the business in food standards terms. The degree to which firms are making claims about their products (eg they are GM-free) also has an effect – if they are making claims they are more likely to be inspected. Products which are labelled as GM are unlikely to be tested. Products that are neither labelled as GM free nor as GM are more likely to be tested if they may contain ingredients that could contain GM (eg products containing soya or maize).

An inspection would normally involve inspection relating to a range of food standard issues, rather than being specifically related to GM. Clearly this makes the extra enforcement costs relating to the different GM labelling options difficult to cost. An inspection would initially involve an examination of the companies' own quality assurance procedures including identity preservation and testing. The next step would be to takes some samples and test them for a range of attributes, including GM if appropriate. For GM the main cost lies in the laboratory testing, rather than the inspection itself. Five or six public health laboratories now have the capacity to test for GM content, which is a specialised test procedure. There are economies of scale in testing, ie the unit cost for a large batch of samples will be lower than the unit cost for a smaller number of samples. Costs for GM tests are in the range £300 to £600 per sample.

Companies such as supermarkets have their own well-developed procedures for identity preservation and testing and they take a similar risk assessment approach to TSOs. There are a large range of labelling schemes where such procedures are necessary eg organic, freedom foods (relates to animal welfare), vegetarian, beef origin etc. Any claims about products that are made on labels are potentially subject to inspection and testing by TSOs.

There are also costs of imposing penalties. In the UK the main penalty on conviction for breach of GM labelling regulations is a fine of up to £5,000. There are costs of administering the penalty as well as legal and court costs. We do not have any estimates of these costs – we understand that they are not separately collected.

Under Option B, the level of testing appropriate under Option A would need to continue, but in addition further checking for compliance with the GM-free labelling standard would be necessary. This would be based on ensuring that the traceability mechanisms in place are accurate and that no fraudulent use is being made of the GM-free label. Under Options C, C+ and especially D a much wider range of food products would be within the scope of

enforcement action and the importance of traceability systems would increase, though it is likely that some testing would still take place. Overall, our view is that the costs of enforcement are likely to increase as the standards set by the options become tighter. (This may not be directly translated into an increase in public sector costs since the budget constraints facing local authority trading standards officers may lead to an increased workload relating to GM labelling displacing some of the activity that currently takes place to monitor other trading standards both within the food sector and in other sectors. However this displacement is no less of a cost to the economy.)

4.3.2.3. The costs of non-compliance

The costs of non-compliance with the labelling regulation are similar to the benefits of GM labelling that we discuss elsewhere in this report. Essentially, the greater the level of non-compliance the less likely that the full benefits of labelling in terms of consumer confidence in the use of GM ingredients will be realised.

The level of non-compliance will be determined by the probability of detection, which is driven by the level of enforcement, discussed above, and the penalties (in terms of marketing probably more than any formal penalty) once detection has occurred. For the purposes of this report we restrict our comments to an observation on the level of current penalties and the possible need to consider this issue further.

4.3.3. International trade costs

International trade in food products is substantial and is substantially affected by GMO regulation. It is not practicable to value either the short term impacts nor the longer term implications, but several general observations can be made.

Political debate on trade is usually centred, overtly or otherwise, on the intuitive and popular idea that it is a battle for jobs – for example that regulatory barriers, such as GM labelling, will enable EU workers to produce instead of overseas competitors and, contrariwise, that restraining technical development in the EU will make the EU "less competitive" and lose jobs to overseas competitors.

To only a very limited extent are these arguments correct. Trade barriers do protect jobs in relatively inefficient industries. But their long term impact on total UK employment is likely to be slightly negative and they generally reduce national income. Restraining technical development may also have a slightly negative long term impact on employment, because the economy is less flexible; but the main impact is on national income, and perhaps on international political influence.

Given both the extreme distortions in world agricultural trade, and the capacity of US producers to adapt to EU regulations, it is in any case unlikely that the differences between alternative GMO labelling regimes will have a marked effect on the level of UK or European agricultural output. The important trade implications are more complex and uncertain.

They appear to be as follows, and are presented here from a UK perspective. The principles apply to the EU as a whole, but all would seem to be of more concern to the UK than to most other Member States.

The first issue is that of world technical leadership. Concerns about Europe lagging in this technology are expressed strongly in the UK, as for example in the House of Lords European Communities Select Committee Report of December 1998. Sir Robert May, in February 1999, when Chief Scientific Advisor and Head of the Office of Science and Technology, made the point as follows.[26]

> "*There is a huge potential market for new GM "agrifood" in Europe. This new industry is just emerging, the fruit of advances in basic research to which the UK has, as in other areas, made contributions out of all proportion to its size. Having laid the foundations, are we once again -- as in electronics, liquid crystal displays, and so much else -- going to see others cash in on our cleverness? For anyone concerned with the future state of the UK economy, this is a hugely important question.*"

Whether or not it is "hugely important", this is a point of substance. The effects will not be to any significant degree on total employment, but they will be on the quality of jobs available. This is a field in which the UK has a comparative advantage – linked for example to its exceptional strength in pharmaceutical research. This whole area of research skills could be weakened, to some degree, by restriction of agricultural GMO.

A second impact is that on trade relationships, especially with the United States. It may be that some GM conflicts, such as the case of dairy foods from cows treated with the hormone rBST, reflect genuine differences of scientific judgement. And consumer demand for GMO labelling, with associated costs of product Identity Preservation, is now established in the US domestic market. However the politically driven nature of trade relationships make it very difficult to judge the impact of the various GM labelling options, other than that any change from the status quo is likely to have some, probably negative, impact and that the more stringent the labelling requirements the more likely this is to cause problems with trade relationships.

A third impact is the UK's general standing on the world stage, particularly in relation to developing countries. To quote Sir Robert May again:

> "*Today's intensive agriculture is not sustainable in the long run. In developed countries, we typically spend ten calories of fossil fuel energy, in various ways, to put a calorie of food on the table; a century ago this ratio was one to one, and in hunter-gatherer times was 0.1 to 1. At least half the atoms of phosphorus and of nitrogen incorporated into new plant material around the world today comes from fertilisers, rather than by natural biological processes. But we cannot turn back the clock, because we could not feed today's global population, much less tomorrow's, with*

[26] May (1999).

> *yesterday's agriculture. Increasing food production has so far kept pace with increasing populations by advances in higher yielding crops -- the Green Revolution -- with their attendant need for fertilisers, clinical pesticides, and the like, along with their adverse and unsustainable impacts on water supplies and biological diversity. Against this background, the world population continues to grow, … in the longer term we need to bioengineer crops which work with nature to reduce the need for intensive use of chemical fertilisers, pesticides, herbicides and fungicides. This is what the UN Food and Agriculture Organisation (FAO) had in mind when it recently spoke of GM agriculture's "actual and potential possibilities of increasing food supplies and alleviating hunger". We want this bioengineering increasingly to have a Third World orientation …* "

This view of bioengineering as a crucial element in the development of world food supplies remains contentious. It is argued that this approach would have serious effects on biodiversity and that "tweaking the edges of conventional agriculture can have amazing effects".[27] However it seems likely that GM agricultural technology, if it as allowed to do so, will have a major impact on some aspects of third world development. If this is the case, it will give diplomatic weight to those countries which are in the forefront of the technology.

Overall, these "trade" impacts are very uncertain, but possibly very important. They all point in the same direction – that is in favour of a regulatory regime which is no more restrictive than is justified by other criteria. The more stringent the labelling requirements, the more likely there are to be higher trade-related costs. We note that taking action to co-ordinate and standardise labelling requirements internationally is the main mechanism for reducing the trade impact of the chosen option. The current discussions in the EU are an example of this approach as are the Codex Alimentarius negotiations and the Cartagena Protocol.

A recent report by the Cabinet Office provides a very useful discussion of the interaction between trade policy objectives and objectives in other areas, such as health and environment, where labelling is one of the potential policy instruments.[28] The report notes:

"*Labelling can often be left to the market to deliver – responding to consumer and producer demand for schemes. Voluntary approaches have a number of advantages including greater flexibility and capacity to reward market leadership through setting high standards.*"

The report also recognises the important role that government can play in some circumstances:

- "*where there is reasonable consumer concern, or health, safety or environmental risks; and*

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[27] Attributed by the Scotsman, 24 April, 2001, to Professor Alan Gray, Director of the Centre for Ecology and Hydrology in Dorset, at a John Innes Centre conference on global farming.

[28] Cabinet Office Performance and Innovation Unit (2000), Chapter 10.

- *where research suggests that labelling is likely to lead to improved SHE [social, health and environmental] outcomes; and*
- *where voluntary schemes fail to achieve the necessary market coverage, or confuse consumers with a proliferation of logos."*

4.3.4. Other costs

We note here two other possible costs arising from the GM labelling options.[29]

First, the introduction of the GM label may to some extent dilute the impact of other labelling information already on food products. The extra information may make consumers less likely to read the label and it may also make the label more difficult to understand. Although we have not seen any quantification of this effect, it is clearly an important point. The benefits attributed to GM and other labelling rely on consumers being able to digest the labelling information.

The second additional cost is that of changes in market structure arising from the higher unit costs facing small businesses as a result of the extra costs of labelling. If the costs of labelling fall more heavily on small business in the food sector then that might lead to a tendency for the sector to become more concentrated, ie for there to be fewer, larger companies, because, given the labelling costs, that is a more cost efficient structure. This increased concentration might lead to increases in market power in some circumstances, which in turn might lead to prices being set at a level where welfare losses are incurred.[30] Distributional impacts on small businesses are discussed in Chapter 7.

[29] Both noted in Golan, Kuchler and Mitchell (2000).

[30] In their report on supermarkets, the Competition Commission (2000) noted, for example, that "the existence of buyer power among some of the main parties has meant that the burden of cost increases in the supply chain has fallen disproportionately heavily on small suppliers such as farmers".

5. QUANTIFICATION OF COSTS

Box 5.1
Summary of Chapter 5: Quantification of Costs

In this Chapter we first describe our approach and assumptions for estimating the base case costs of identity preservation in the supply chain (Section 5.1) and then, our approach and assumptions for estimating base case enforcement costs (Section 5.2). These, and other, unquantified costs, are discussed further in Chapter 4. Sensitivity analyses are discussed in Chapter 6.

For identity preservation costs the approach taken is as follows:

- First, we estimate the unit costs of segregation and traceability per tonne of crop using existing research and then we estimate the amount of domestically processed crop that these costs will be applied to under Options A, C and D.
- Next, we consider the segregation and traceability costs incurred by processors outside the UK who export their products here, assuming that the extra costs will be reflected in import prices.
- This establishes the framework for calculating the base year costs of identity preservation under Options A, C and D. Options B and C+, which are considered next, depend on the uptake of the voluntary GM-free labels and are assumed to be a function of the costs under Options A, C and D.
- We then consider how these costs may change over the next 20 years as a result of changes in the amount of food produce needing to be segregated and changes in unit costs.

For enforcement costs, we review the available data on current enforcement actions in the UK and then describe the assumptions we make about enforcement costs for each of the labelling options. The two types of enforcement costs that we have quantified are:

- the cost of GM laboratory tests;
- the cost of inspection.

Our base case estimates of identity preservation and enforcement costs are set out below.

Table 5.1
Base Case Estimates of Quantifiable NPV Costs (£m)

	Option A	Option B	Option C	Option C+	Option D
IP Costs	93	258	720	820	1,588
Enforcement Costs	3	3	5	5	6
Total Costs	96	261	725	825	1,594

5.1. Costs of Identity Preservation

5.1.1. Overview

In this Section we outline our approach to estimating the costs associated with identity preservation (IP). We start with a description of the model and our assumptions for the base year and then describe how we take account of changes over time. Conceptually the approach is simple and we have split the process into three basic steps, as follows:

- Initially, we estimate the base year costs of IP associated with products that are manufactured in the UK from either imports or domestic production of crops that could be genetically modified (i.e. that may need to be segregated). We have focused on maize, soya, oilseed rape and wheat.
- IP costs will also apply to imports of processed food products to the UK (i.e. those that are not manufactured in the UK). We use estimates derived from the first step as the basis for estimating the likely magnitude of these costs in the base year.
- The volume of products that are GM, the degree of segregation required and unit IP costs will all change over time and so we make assumptions about the rates of change for these factors over the twenty year period of our appraisal.

We have developed a model that projects the likely costs of IP over the next 20 years and calculates the net present value of those costs.[31] In the discussion below, we focus on our methodology and our baseline assumptions and discuss each step of the calculation in more detail.

5.1.2. Base year IP costs for domestically manufactured products

The starting point for the model is to identify imports and domestic production of the crops we are focusing on (soya, maize, oilseed rape and wheat). We emphasise these crops because they are the principal crops where genetically modified versions are either widely used or have the potential to become so in the next few years. They are also present in a variety of food and feed.

Throughout the report we have aimed to use the term “segregation costs” to refer to the cost of physically separating products, the term “traceability costs” to refer to the costs of systems for documenting the origins and nature of food products, and “identity preservation” or “IP” as a generic term that encompasses both segregation and traceability costs. Segregation and traceability are both inevitable consequences of the proposed requirements for GM labelling except, perhaps under Option A. Segregation is required to

[31] For the net present value calculation we use a real discount rate of 6 per cent. This is the discount rate that HM Treasury advises should be used for most central government applications. See HM Treasury (1997).

ensure that the food products in the various GM or non-GM categories are not contaminated and can meet the requirements of the label definitions, whilst traceability is required to ensure that this is documented and recorded when it is not possible to use analytical tests to determine the GM content of the food product in question.[32]

From our literature review, we have derived estimates of the costs of segregation, measured as cost per tonne, which can be applied to the quantity of imports and domestic production. However, not all imports or domestic production of the relevant crops will need to be segregated. All will require traceability, but only some will need to be segregated. For example, under Options C and D, products that may come into contact with GM products will need to be segregated if they are to avoid a GM label. But if a manufacturer deals only with GM-free materials, the costs of segregation will be greatly reduced (although traceability costs will still be incurred). Assumptions therefore have to be made about the proportion of imports and domestic production that will require segregation under each Option.

This proportion may vary over time and will be different for each option. For example, under Option D some imports of maize that are destined for use in animal feed will require segregation, but these will not be segregated under the other options. This will influence our assumptions about both the proportion of maize that will be segregated under Option D and the quantity of imports that this proportion is applied to.

Table 5.2 presents our base assumptions about the proportion of imports and domestic production of each relevant crop that will need to be segregated under each Option. Since the purpose of this appraisal is to aid in the choice of labelling option, it is important to stress that it is the differences between the options, ie how the assumptions of segregation levels vary across the Options, that are important rather than the exact level of costs and benefits. Box 5.2 explains how we have arrived at our assumptions about segregation levels. (Note that the Table only contains information for Options A, C and D. We discuss Options B and C+ later in this Chapter.)

Table 5.2
Assumptions About Initial Segregation Levels

	Wheat	Oilseed Rape	Maize	Soya
Starting segregation levels:				
Option A	0%	0%	20%	0%
Option C	0%	47%	30%	40%
Option D	0%	47%	40%	40%

[32] For a discussion of this link between traceability and segregation see European Commission Directorate General for Agriculture (2000).

Box 5.2
Defining Segregation Levels

The segregation level refers to the proportion of relevant crop which the IP costs will be applied to.[33] This level differs according to the option being considered. Option A, for instance, does not require the labelling of oils that are chemically identical to non-GM oils. Thus the crop destined for use as oils need not be subject to identity preservation. By contrast, under Option D, these crops would need to be segregated and, in addition, Option D would also require IP, for example, of crops destined for animal feed.

Our starting point for estimating the proportion of a crop to be segregated has been to look at the volume of "non-GM" crops currently consumed. As no robust data are available, we have used the country of origin as an indicator of the current level of non-GM crop. Thus the proportion of non-GM crop to be segregated is taken as the percentage which comes from countries which currently grow (almost entirely) non-GM crop. Thus, for soya we have taken imports from Brazil to represent the non-GM sector (sowing of GM crops are now illegal in Brazil and public authorities are committed to control them, although some sources mention that at least 10% of the crop are GM).[34] Soybeans from the US and Argentina, on the other hand, are assumed to remain unsegregated, since both GM and non-GM crops are grown and segregation currently is only very limited.[35] For maize, we have taken the amount of crop originating in Europe (although small amounts of GM crop are grown in Spain and Portugal) to represent the non-GM sector. GM wheat is currently not approved for import into Europe and so the initial segregation level for this crop is zero. The situation for GM oilseed rape is more difficult since the crop is not approved for use in Europe but the oil derived from the GM crop is,[36] although it is not used in the UK at the moment.[37] We have therefore assumed that all oil is currently segregated, and therefore incurs segregation costs, but no segregation costs are incurred for the unprocessed crop, since, as with wheat, this must be segregated regardless of labelling legislation.

Of course, the level of segregation in these countries may change if the EU legislation on labelling changes. The extent of such responses is extremely hard to predict, but we discuss in more detail below how we have assumed segregation levels will change over time.

Once the proportion of the relevant crops to be segregated has been calculated, the segregation costs are derived by applying assumptions about unit segregation costs (per

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33 By "relevant" crop we mean the volume of the crop in question (eg maize) which could lead to a final food product being labelled as GM. For example, almost 90 per cent of maize is used for animal feed in the UK and so the proportion of "relevant" maize under Options A and C is only about 10%, whereas it is 100% under Option D. Segregation costs are not applied to the whole of the "relevant" crop because if, for example, only 5% of the crop is GM, most processes using the crop will have no contact with the GM crop and therefore no need to incur significant segregation costs.

34 European Commission Directorate General for Agriculture 2000, section 1.1.

35 European Commission Directorate General for Agriculture 2000, section 5.5.1.

36 House of Commons 2000 Vol II pg 168: correspondence with European Food Information Council.

37 www.foodstandards.gsi.gov.uk

tonne) at the farm, handling and processing/manufacturing level to the quantity to be segregated. Some of the literature mentions costs at other stages in the food supply chain, for example at the retail level. However, IP is unlikely to include significant additional costs to food retailers. A discussion of estimates of these costs at the retail level is provided in Box 5.3. We have also assumed that caterers would incur no additional costs. If any segregation were to occur at this level, we have effectively assumed that it would already be dealt with through existing hygiene mechanisms.[38]

The costs of traceability (i.e. of having a "paper trail") are estimated in a similar manner, although in Options C and D we have assumed that traceability costs apply to all imports and domestic production of the relevant crops. (Because the presence of a GMO cannot be tested for under these Options, all products will require a paper trail to confirm whether or not they are GM.) Under Option B we have assumed that only those products labelled as "GM free" will incur traceability (and segregation costs). Traceability costs will be higher under Option C+ than under Option C, in reflection of the additional "GM-free" label.

Table 5.3 illustrates our assumptions about IP costs. These are the assumptions used in our base case.

Table 5. 3
Assumptions About IP Costs (Euros per Tonne)

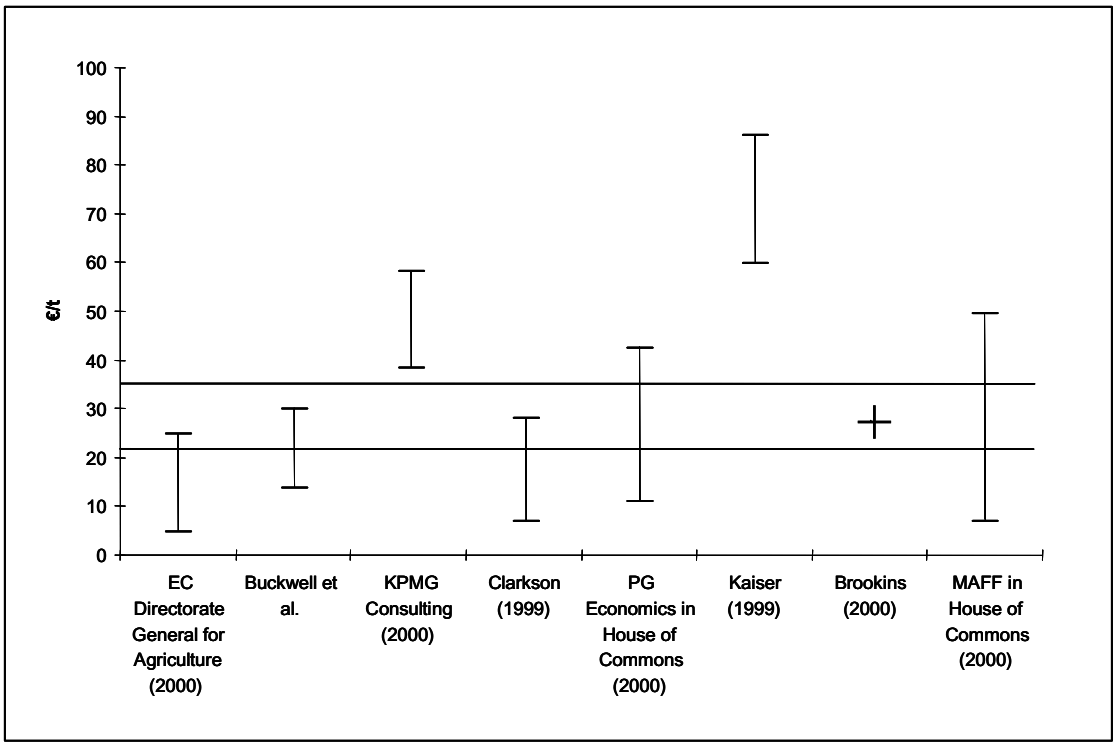
	Wheat	Oilseed Rape	Maize	Soya
Farmers	6	11	6	10
Grain Elevator and Handling	6	11	6	10
Processors and Manufacturers	10	13	10	12
Total	**22**	**35**	**22**	**32**

These estimates are based on our collation and analysis of figures that are quoted in the literature, and include both segregation and traceability costs. Figure 5.1 shows the range of IP cost estimates which different studies give. For illustration, the estimates have all been converted into €/tonne.[39] The lower horizontal line represents NERA's estimate of the unit cost of segregation for maize (22€/t) and the higher horizontal line the cost of oilseed rape (35€/t).

[38] We note that the Better Regulation Task Force (2000) said that "*The regulations concerning labelling of GM foods in restaurants…..are arguably unenforceable and there is little evidence of consumer concern (unlike food sold in supermarkets).*" We discuss evidence on consumer views on GM foods more generally in Chapter 3.

[39] Where the IP cost was quoted as a percentage of the farmgate price the estimates were converted using a price of 170€/t for soyabeans and 75€/t for corn.

Figure 5.1
Comparison of IP Cost Estimates (€/tonne)



NERA's own estimate is formed by taking all these studies into account, along with many other partial estimates of the cost at each stage. The weight attached to the estimates differed according to the scenario considered (in terms of tolerance level, crop etc) and also according to the level of research which went into the estimate. Thus the estimate quoted in the Reuters World Report, which was much higher than many of the other estimates, was given a rather low weight as it was simply an educated guess by an industry professional. The Buckwell study, on the other hand, was more thoroughly researched and accorded closely with the situation considered in this report. Box 5.3 summarises how we used the results of these other studies to arrive at our own estimates.

Box 5.3
Defining Segregation Costs and Traceability Costs

Segregation Costs

The estimates for the cost of segregating GM and non-GM material were based on examples and estimations of IP costs quoted in published studies, submissions to the UK Agriculture Select Committee, who produced a report on the segregation of genetically modified foods,[40] and other articles taken from trade publications.

The costs were broken down into three levels; farmer, handler, processor/manufacturer. Retailer costs were assumed negligible in comparison to the size of other costs. This is supported by the only two studies which consider such costs, which state that the costs to the retailer of segregating "*are no different from those a retailer already accepts*"[41] or alternatively that they "*are not expected to be on the same scale as the other costs*".[42]

The estimates of the segregation costs vary widely between the different sources. The majority of estimates are in the range of 10–30 euros per tonne,[43] though two estimates suggest higher premiums in the range 45-80 euros per tonne (as illustrated in Figure 5.1).[44] Based on this evidence, and the other factor discussed below, we have assumed for our base case that the costs of segregation are 22 Euros per tonne for maize and wheat and 32 Euros per tonne for soya and 35 Euros per tonne for oilseed rape. The variation in the estimates from the literature may be in part due to the lack of systematic research into the area (many estimates quoted are simply educated guesses) but it also reflects the variations in details. Factors such as the nature, quantity and use of the crop under consideration play an important role in determining the level of the costs. We present the estimates we have identified in the literature in more detail in Appendix B.

Estimates for segregating soybeans, for example, are generally higher than maize. This is despite the fact that soya is largely self-pollinating so contamination at the farm level is not as large a problem as for maize, which is usually wind-pollinated and so much more vulnerable to cross fertilisation.[45] Only one publication[46] gives an estimate for the cost of segregating oilseed rape and since it is not possible to tell how representative this is (for example, it may refer to a rather generous tolerance level) we have based the costs of segregating oilseed on the estimates used for soyabeans, but allow it to be slightly higher because of the smaller quantities involved. We have seen no estimates relating to the IP costs of wheat and so we have assumed that the costs of segregating wheat will be similar to

40 House of Commons (2000).

41 Clarkson (1999), page 8.

42 KPMG Consulting (2000), page 33.

43 Brookins (2000), Buckwell et al., Clarkson (1999), Cargil in House of Commons (2000), European Commission Directorate General for Agriculture (2000)

44 PG economics in House of Commons (2000), MAFF in House of Commons (2000), Kaiser E (1999)

45 House of Commons (2000) volume III, page 170.

46 Buckwell et al.

maize.

Perhaps the largest reason for the variation in the estimates is difference in tolerance levels. Most commentators refer to the tolerance level as a key factor in determining costs. In most cases where estimates of IP costs are provided, the assumed tolerance level is not quoted, but we understand that most farms currently practice 'soft IP', and, for example, do not wash down equipment between batches, it is probable that most estimates relate to rather generous tolerance levels. Since we have assumed a stricter 1% tolerance level, our base estimates are higher than many of those quoted in other studies.[47]

A further tightening of the tolerance level would be expected to result in a sharp increase in costs.[48] Buckwell et al, for example, estimate the price of segregating non-GM herbicide resistant soyameal protein such that there is no detectable residue (0.01 per cent in practice) as 119€/tonne, equivalent to an increase in the commodity price of 50 per cent. PG Economics estimate that whilst the costs of segregating soya meal are 15-25 per cent of the farmgate price for a tolerance of 1-2 per cent, they range up to 150 per cent where there is no detectable residue.[49]

Traceability Costs

The estimates of the segregation costs from other sources are assumed to include the costs of traceability (i.e. the paper trail required to identify the origin of the ingredients), since they are generally quoted as identity preservation costs, which entail both segregating and tracing the materials. EC labelling regulation requires that the label on a product indicates not only whether the food is GM, but also the nature of the GM content (i.e. soya or maize).[50] Thus traceability requirements extend to products that contain GM material. We did not apply these costs to GM products under option A since a paper trail is not required as it is possible to test for the presence of GM material. In some cases a paper trail may be required in order to prove that any contamination below the 1% level was adventitious.

Estimating what proportion of the costs are due to maintaining the paper trail is hard since the estimates of the costs are often not broken down into sufficient detail, although the figure is expected to be substantially below the cost of segregation. Traceability is already required for many products because of quality assurance schemes such as the Assured Combinable Crops Scheme or the British Farm Standards and other labelling schemes such as organic, the compulsory beef labelling scheme, and animal welfare schemes such as "freedom foods". However, the additional traceability requirements of the proposed GM labelling legislation may increase costs further due to the greater

47 This is consistent with the two estimates, by PG economics and Cargil in House of Commons (2000), which mention tolerance levels. However, Buckwell et al quote an example for lecithin with a tolerance level of 0.1-1% with an extremely low IP cost (0.8 dollars per tonne).

48 PG Economics in House of Commons (2000) pg 133, Volume II, Lin W et al. (2000) pg 31 and interviews with NFU. Recent work by Arcadia International for the NFU, Sainsbury and MAFF, however, suggests that these increases may not be so steep for soya imported from Brazil or India.

49 House of Commons (2000), Vol II, pg 133

50 MAFF (1999) pg 7

51 KPMG Consulting (2000), pg 23-24

52 Farmers; grain elevators and handling; processors and manufacturers.

range of materials involved and details required.

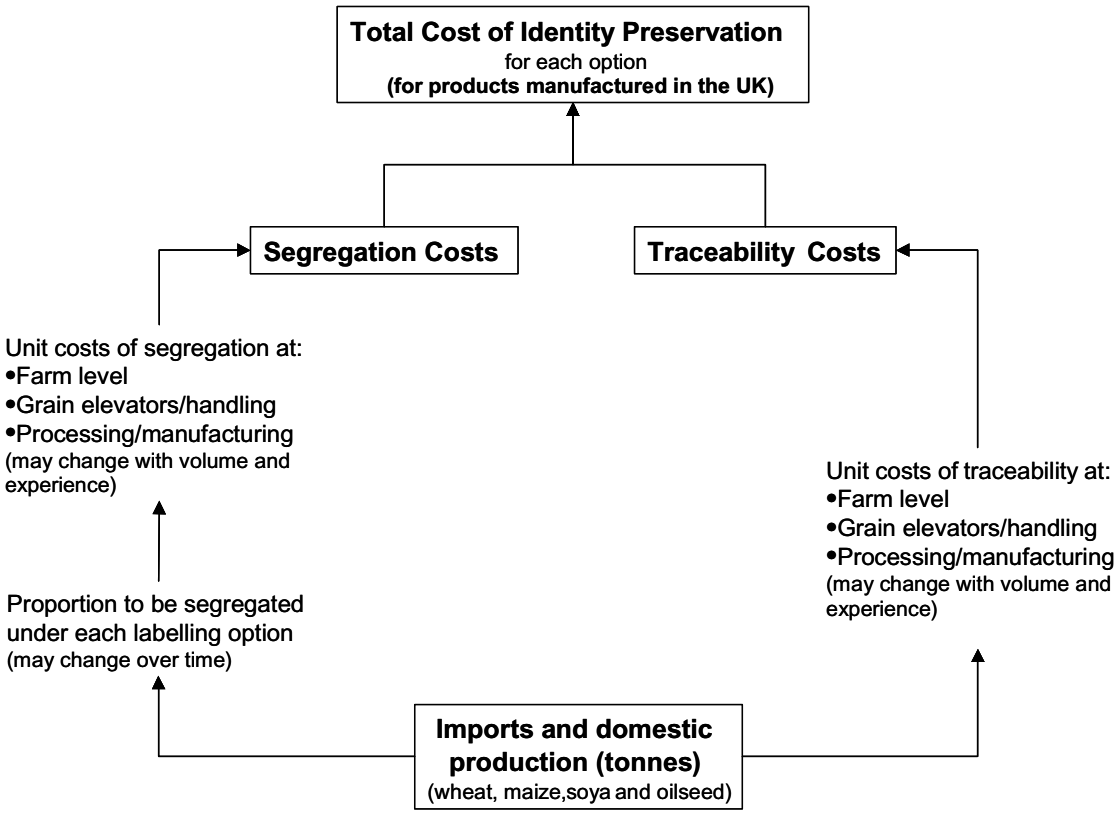
The only study that we are aware of which provides any specific estimates of traceability costs is KPMG's Canadian study which estimates the farm level cost of certification as 0.04 dollars per bushel (around $1.5 per tonne),[51] although they admit that the cost has been arbitrarily assigned. Taking this estimate as our starting point we have assumed that the additional traceability costs are one Euro per tonne for each of our three supply chain stages[52] with an extra one Euro per tonne for the processing stage as this stage may reflect many vertical interactions between companies. Our estimate of total traceability costs is thus four Euros per tonne.

Combining estimates of the segregation and traceability costs gives an estimate of the total costs of IP for domestically manufactured food. The variation in costs across labelling options is driven by changes in the quantity of the relevant crops that are segregated under each option. These costs exclude any IP costs associated with imports of foods that are already processed. At this stage, the estimates only include products that are manufactured / processed in the UK using imported or domestically produced wheat, maize, soya or oilseed.

It is also important to emphasise that not all of these IP costs will be incurred in the UK. Segregation of imported products, for example, will be a cost to non-UK farmers, but we assume that the magnitude of these costs is the same as for UK-based production and that they are passed through the supply chain in the same way, such that they are reflected in higher import prices.

Figure 5.2 provides an overview of our approach to estimating the IP costs for domestically produced foods.

Figure 5.2
Estimating IP Costs for Domestically Manufactured Foods

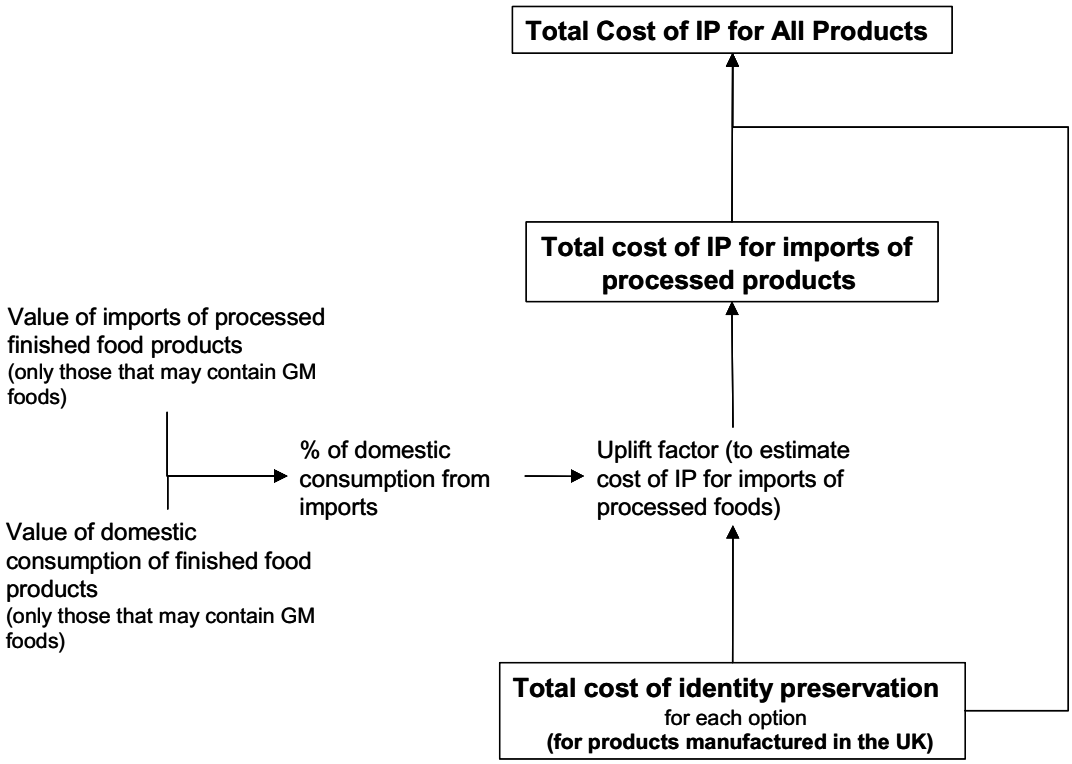


5.1.3. Base year IP costs for imports of processed products

The discussion of IP costs so far has focused on products that are manufactured or processed in the UK. It includes all products manufactured from domestically produced or imported wheat, maize, oilseed and soya. However, some products will be imported ready-processed and so far are not included in our calculations. The labelling options will require that these products comply with IP legislation and there will be segregation costs associated with this, which need to be included.

Figure 5.3 illustrates how we have estimated the costs of IP for imports of processed foods. Our starting point has been to compare data on total UK consumption of foods with imports of food to estimate the proportion that comes from imports of processed foods. This provides an "uplift factor" which can be used to calculate the additional IP costs due to imports of processed foods. If for example, imports of processed foods account for 10 per cent of total UK consumption of food, we assume that the IP costs for imports will add 10 per cent to our estimate of the IP costs of domestically produced foods. (This implicitly assumes that unit IP costs are the same in the UK and overseas.)

Figure 5.3
Estimating the IP Costs for Imported Processed Foods



The "uplift factor" used varies across the Options. In estimating the proportion of UK food consumption derived from imports of processed foods, the foods included vary depending on whether they would be covered by the labelling regime. Therefore, for example, imports of meat are excluded from Option A, but are included in Option D.

Adding the additional IP costs of imported processed foods to our estimate of IP costs of domestically manufactured foods gives our estimate of overall IP costs for each option.

5.1.4. Base year IP costs for options B and C+

Our estimates of the segregation costs associated with Options B and C+ assume that they are a direct function of the costs of other Options. Under both, there is a non-mandatory scheme where products can be labelled as GM-free provided they meet the required definition. We have assumed that this definition is consistent with the coverage of products under Option D (i.e. it includes, for example, processing aids).

The overall IP costs of these GM-free lines are driven by the uptake of the GM free line. Option B also assumes that the status quo is maintained (i.e. Option A). We have therefore estimated the cost of Option B as equal to Option A plus a proportion of the difference in IP costs between Options D and A. This proportion reflects the uptake of the GM-free line,

which we have assumed to be 5 per cent initially. For Option C+ we have followed an analogous approach. The total IP costs are estimated as the cost of Option C plus five per cent of the difference between Option D and Option C.

The five per cent uptake has been based on the uptake of products labelled as organic, which is also promoted through positive labelling. Many of the driving forces behind consumer demand for organic produce are also relevant to GM-free foods. These include concerns over food safety, the perception that organic (or non-GM) food is of higher quality and is more healthy and an increasing interest in the environment and other ethical issues which organic (or non-GM) food appear to represent.[53]

The trend in the growth of organics is shown in Figure 5.4. Although the rate of increase in the organics' market is impressive, the market accounts for only a small proportion of the UK food market (2.5 per cent) and doubts have been expressed about the ability of the market to sustain such growth.[54] Sainsbury's predict that the market will begin to level out in 2003 or 2004 and will reach a peak by 2010.[55]

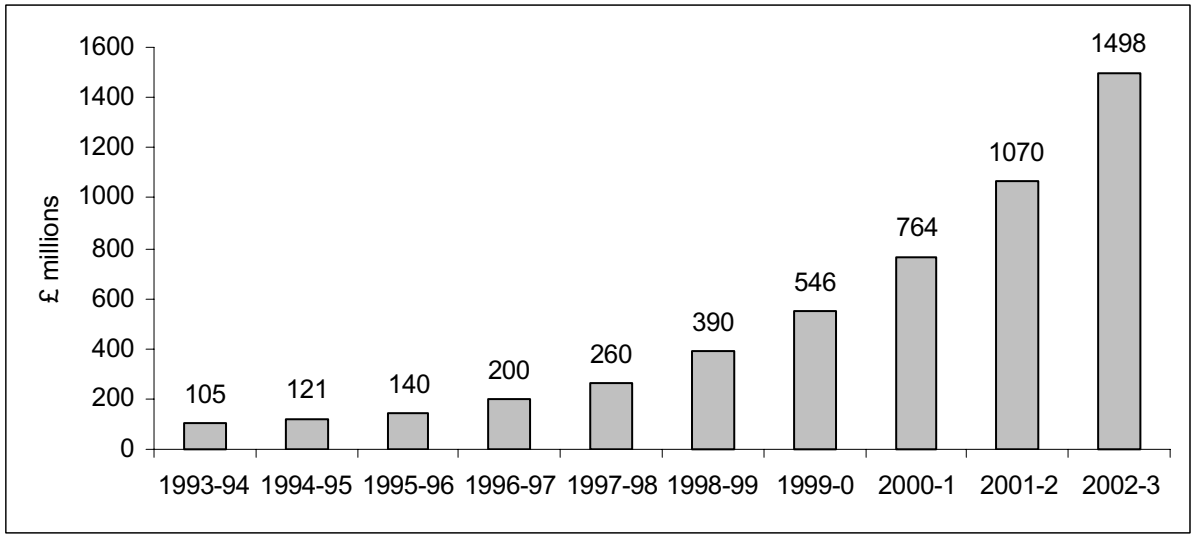
On this basis, we have assumed that the initial uptake of a GM-free line would be 5 per cent (GM-free products are likely to be cheaper than organics and so may account for a higher share of the market). We have assumed that this share will grow over time, reaching a market share of 20 per cent over the next 20 years.

[53] House of Commons (2001), paragraph 24.

[54] House of Commons (2001), paragraph 20.

[55] House of Commons (2001), paragraph 20.

Figure 5.4
The Market for Organics: UK Retail Market Growth (Actual and Projected)



Source: Soil Association (1999), p. 22., reproduced in House of Commons (2001) paragraph 20

5.1.5. Changes in IP costs over time

5.1.5.1. Segregation levels

It is likely that the quantity of segregated material will change over time as both consumer and supplier behaviour changes in response to the new legislation. We account for this in the model by allowing segregation levels to change over time. No studies we know of have addressed this issue, so our assumptions about changes over time are judgements rather than evidence-based. In the sensitivity analysis presented in Chapter 6, we assess the implications of alternative assumptions about changes over time.

Table 5.4 summarises our assumptions about changes in segregation levels. We discuss some of the relevant issues below. The Table shows our assumptions of base-year segregation levels and the higher segregation levels achieved after 20 years. We have assumed that two thirds of the growth over the twenty year period occurs in the first ten years and that one third occurs in the second ten years. The faster growth in the first ten years is intended to reflect the possibility that the current moratorium on the licensing of new GM products may have led to a backlog in potential GM products which could lead to faster growth in the proportion of goods needing to be segregated in the earlier years of the period.

Table 5.4
Segregation Levels: Changes Over Time

	Wheat	Oilseed	Maize	Soya
Segregation level in 2001:				
Option A	0%	0%	20%	0%
Option C	0%	47%	30%	40%
Option D	0%	47%	40%	40%
Segregation level after 20 years:				
Option A	30%	60%	40%	60%
Option C	40%	75%	60%	70%
Option D	80%	80%	80%	80%

In the case of maize, an increase in the amount of imports from Europe has already materialised in response to increased demand for non-GM products. EU purchases of US corn now represent less than 1 per cent of US corn exports (300,000 tonnes), a drop from 4 per cent.[56] In addition to this move towards EU-grown crops, which are largely non-GM, we expect that American exporters will begin to segregate – 25 per cent of US elevators have indicated they will segregate corn (Pioneer Hi-bred International 2000),[57] which is more than enough to cater for all EU-exports. Thus we expect increases in segregation.

The EU is currently fairly dependent on US soya bean production, so a dramatic drop in the US/EU soybean trade is unlikely.[58] However, if the US started segregating we would expect the segregation levels to increase substantially. Again, 20 per cent of US elevators have indicated they will segregate soya, which is enough to supply the entire EU market (which represents around 8 per cent of US production).[59] We expect substantial increases in segregation levels for these crops.

GM wheat is not approved in the EU at present. It is currently only approved in Canada for feed, but it is expected that the acreage will rise in the next 2 to 4 years.[60] In Europe, the cultivation of GM wheat is not expected at the moment. How segregation levels for wheat may change over time depends on whether it is approved for consumption in the EU. It is hard to accurately estimate the potential uptake if this happens, though we have assumed a significant application of segregation costs.

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56 Ballenger et al (2000).

57 European Commission Directorate-General for Agriculture (2000), section 5.5.2.

58 Ballenger et al (2000), pg. 26.

59 Ballenger et al (2000), pg. 25.

60 European Food Information Council website – www.eufic.org.

We have assumed that in 20 years time segregation levels for oilseed will rise (to 80 per cent, in the case of Option D), reflecting the likelihood of more widespread use of GM products in general and therefore the need to segregate. Indeed, this logic has applied to all the crops that we have considered in the model.

In all scenarios, the proportion of goods produced abroad, rather than domestically, is assumed to remain the same and the exchange rate is also assumed constant.

As indicated at the beginning of this section, no studies we know of have addressed this issue, so our assumptions about changes over time are judgements rather than evidence-based. We have assumed that the maximum segregation level for each crop under Option D is 80%. Since it is likely that some operators will specialise in producing specific categories of food such as GM-free only or GM only then the segregation costs for these foods will be very low, or perhaps non-existent, and consequently a 100% segregation level is unrealistic. Whilst more than 20% of producers may follow this route, this may be offset by possible losses in economies of scale from this specialisation and so we have used 80% as our base case assumption for Option D.

5.1.5.2. Segregation costs

Unit segregation costs are expected to decrease with time as experience of segregation methods is increased, dedicated machinery or plants are set up and quantities of segregated crops increase.[61] Again, there are no studies that we know of which quantify this effect so we have assumed a decrease in the IP costs of 2 per cent per year for our base case. Paper trail costs are assumed to remain constant.

Table 5.5 illustrates how this 2 per cent per annum decrease affects unit segregation costs over the next 20 years. (All costs are presented in real terms.)

[61] Buckwell et al page 14; House of Commons (2000) page 129.

Table 5.5
Unit Segregation Costs: Changes Over Time

	Wheat	Oilseed	Maize	Soya
Unit segregation costs in 2001 (€/tonne):				
Farmer	6	11	6	10
Grain Eevator & Handling	6	11	6	10
Processing & Manufacturing	10	13	10	12
Unit segregation costs after 20 years (€/tonne):				
Farmer	4.0	7.3	4.0	6.7
Grain Elevator & Handling	4.0	7.3	4.0	6.7
Processing & Manufacturing	6.7	8.7	6.7	8.0

All future costs derived from model are reported in net present value terms, which are calculated using a using a constant real discount rate of 6% over 20 years.[62]

5.1.6. Estimates of IP costs for the base case

Based on the processes described above, Table 5.6 summarises our baseline estimates of the costs of IP for each of the labelling options. The Table shows segregation and traceability costs separately, as well as the total IP costs. The costs are the total over the next 20 years and have been presented in net present value terms. Figures are shown for both Sterling and Euros.

[62] HM Treasury recommend the use of a real discount rate of 6% for most central government applications.

Table 5.6
Baseline IP Costs (presented in NPV £m and €m)

Option	Segregation costs	Traceability costs	Total IP costs
Net Present Value (£m):			
Option A	93	0	93
Option B	200	58	258
Option C	452	268	720
Option C+	521	298	820
Option D	1,024	564	1,588
Net Present Value (€m)			
Option A	155	0	155
Option B	333	97	430
Option C	754	447	1,201
Option C+	869	497	1,366
Option D	1,707	939	2,646

The IP costs increase significantly as the labelling requirements become more stringent, from an NPV cost of £93m for Option A through to an NPV cost of £1,588m for Option D. The costs increase almost threefold when moving from Option B to Option C, and increase significantly again when moving to Option D. These large increases reflect the much wider range of products that are likely to need to be segregated and to incur traceability costs under Options C and D.

Since we have not been able to quantify all costs and since we focus on four main crops, we believe that these estimates are more likely to be underestimates of the impact of the labelling options on IP costs than to be overestimates.

5.2. Enforcement Costs

The main issues associated with assessing enforcement costs are discussed in Section 5.2. In this Section we outline our approach to quantifying those costs for each of the labelling options.

Statistics on the enforcement of food standards are collected by the Food Standards Agency. The Official Control of Foodstuffs Statistics for 1999 provide data on the number of food businesses subject to inspection in relation to food standards and on the number of inspections by types of establishment. There is no further breakdown of the number of inspections available. The number of prosecutions is available and is split by category but there is no separate category available specifically for GM labels – prosecutions which cover GM labelling issues are included in the category "Labelling and presentation". In 1999, 284 prosecutions were allocated to the "Labelling and presentation" category out of a total of

1,087 prosecutions. These followed from a total of 532,452 formal inspections, which led to 179,897 establishments found to have been committing infringements.

The data collected by the FSA also show the number of formal laboratory samples taken by type of food product, showing the number of infringements. These formal samples are needed if any prosecution is to follow. These need to meet specific standards, such as being undertaken by a suitably qualified person etc. From a total of 50,579 samples, 445 related to the "labelling and presentation" category.

Local authorities also take "informal" samples where the requirements are less onerous. This is principally to "spread the net wider" given limited resources (time and qualified personnel). In total 26,450 informal samples were taken in 1999 of which 5,059 were found to be unsatisfactory. These figures are additional to the data on formal samples provided in the official statistics. Where samples are unsatisfactory Trading Standards Officers can use that to persuade the relevant company that they should be improving their procedures and, if necessary, can follow up with a more formal test as part of the process for initiating legal action.

We summarise below the assumptions on enforcement costs that we have made for each of the labelling options. These assumptions are based on very little evidence and are intended to be illustrative of the possible impacts of the labelling options on enforcement costs.

5.2.1. Option A enforcement costs

We quantify two costs: the cost of laboratory testing for GM content and the cost of extra inspection time allocated to GM labelling.

We assume that the average cost per GM test is £450 (mid way in the current cost range of £300 - £600 per test) and that the number of tests remains constant over the twenty year period of the appraisal at 110 tests per annum. This number, which has no firm basis, is equivalent to about one quarter of the total number of laboratory tests in 1999 that related to "labelling and presentation". We have assumed that this includes any informal GM-related tests.

We assume that the extra cost of inspection time allocated to GM labelling is £25 per relevant inspection. We have no firm basis for this figure, other than advice that the cost of extra inspection time is much lower than the cost of the GM test. We have applied this cost to 7,000 inspections per annum. This number is derived from an assumption that around 5 per cent of the prosecutions relating to "labelling and presentation" can be attributed to GM labelling, and also that the ratio of GM labelling prosecutions to GM inspections is the same as the ratio of total prosecutions to total formal inspections.[63]

[63] This figure of 7,000 GM related inspections is just over one per cent of total food related inspections.

5.2.2. Option B enforcement costs

The difference between Option B and Option A is the introduction of the standardised "GM-free" label. Since the standards associated with the GM-free label are equivalent to Option D standards, the extra costs will be the result of extra inspections rather than extra laboratory tests. We assume that the costs of GM tests continue as under Option A, but that the costs of inspections increase as a result of the wider range of products that are affected by Option B. We assume that the number of GM inspections immediately increases to 10,000 per annum under Option B and that the number remains constant at this higher level over the twenty year period of the appraisal.

5.2.3. Option C enforcement costs

We assume that the costs of GM tests continue as under Option A, but that the costs of inspections increase as a result of the wider range of products that are affected by Option C. We assume that the number of GM inspections immediately doubles from the Option A level to 14,000 per annum under Option C and that the number remains constant at this higher level over the twenty year period of the appraisal.

5.2.4. Option C+ enforcement costs

We assume that under this option, the effects under Options C and B are combined. Thus, the costs of GM tests continue as under Option A, but that the number of GM inspections immediately doubles to 14,000 per annum as under Option C and that there are an additional 3,000 inspections per annum to reflect the GM-free element of Option C+ as in Option B. The total number of GM inspections is thus 17,000 per annum and remains constant at this higher level over the twenty year period of the appraisal.

5.2.5. Option D enforcement costs

We assume that the costs of GM tests continue as under Option A, but that the costs of inspections increase as a result of the even wider range of products that are affected by Option D. We assume that the number of GM inspections immediately rises to 20,000 per annum under Option D (compared to 17,000 under Option C+) and that the number remains constant at this higher level over the twenty year period of the appraisal.

5.2.6. Enforcement costs – summary

Our assessment of NPV enforcement costs is set out in Table 5.7 below. These figures are included in our base case assessment of enforcement costs.

Table 5.7
NPV Enforcement Costs for Each GM Labelling Option (£m)

£m NPV	Option A	Option B	Option C	Option C+	Option D
GM Testing Costs	0.6	0.6	0.6	0.6	0.6
GM Inspection Costs	2.0	2.8	4.0	4.8	5.7
Total Costs	**2.6**	**3.4**	**4.6**	**5.4**	**6.3**

The only study we found that estimated enforcement costs was the KPMG study in Australia and New Zealand.[64] This provides a range of estimates for Australia depending on the level of enforcement. Our estimates lie at the lower end of this range, even without adjustment to reflect the fact that the UK has a much larger population than Australia. Part of the reason for this is that we have assumed greater reliance on existing enforcement systems for food standards with consequently much lower additional costs per inspection. KPMG also include other costs that we have not included, such as prosecution costs, but these appear to have little influence on the totals.

The costs of enforcement are dependent on any specific requirements for enforcement that there may be in any forthcoming EU regulations. We assume that the current UK enforcement regime remains unchanged. In order to avoid falls in consumer confidence in GM foods arising from perceived levels of fraud in GM labelling, successful enforcement may also depend on achieving consistent implementation across Europe, with clear agreed thresholds, detection methods and enforcement regimes.

[64] KPMG (2000).

6. COMPARING COSTS AND BENEFITS

Box 6.1
Summary of Chapter 6: Comparing Costs and Benefits

In this Chapter, we draw on our quantification of identity preservation costs and enforcement costs in Chapter 5 and on our discussion of benefits and other costs in Chapter 4 to compare the full costs and benefits of the options using scoring and weighting techniques.

We present and explain a base case scenario which suggests that Option B is the preferred option with Option C+ ranking second. Option A ranks third, with Options C and D performing much less well. We then present a number of sensitivity tests where, one by one, we adjust a number of our assumptions. The choice of Option B as the preferred option remains robust to these tests.

Finally, we present two alternative scenarios where we aim to present the most plausible set of assumptions that would, first, lead to Option A being preferred and, second, lead to Option C+ being preferred. We believe that the case where Option C+ is preferred is more plausible than the case where Option A is preferred, but that it is not as plausible as the range of cases where Option B is preferred.

6.1. Weighting and Scoring

As indicated earlier in the report, it is not possible to value all of the costs and benefits of GM labelling. Consequently we have compared the costs and benefits of the options using scoring and weighting techniques. Our approach is consistent with that recommended in the recent manual on the application of multi-criteria analysis to government decision-making.[65]

This approach provides a clear framework for assessing the options, and forces the appraiser to be transparent about all the assumptions and trade-offs inherent in the appraisal. Given the wide uncertainties associated with any appraisal of options for GM labelling, most readers are likely to disagree with at least some of the assumptions that we have used. However the framework we present enables readers to judge the impact of using their own preferred assumptions.

We examine a number of alternative scenarios below. A more detailed discussion of the nature of the costs and benefits is provided in Chapter 4. We focus here on quantification.

[65] DETR (2000).

6.2. Construction of a Base Case

Our baseline scores and weights for each option are illustrated in Table 6.1. They show that, under these baseline assumptions, Option B has the highest weighted score, with Option C+ in second place, followed by Option A.

Table 6.1
Scores and weights – Base Case

	1	2	3	4	5	6	7
	Costs which can be valued £m PV	**Trade Costs**	**Other costs not valued**	**Benefits from Standardisation of "GM-free" definition**	**Benefits from restoring public confidence**	**Total weighted score**	**Weighted score relative to A**
Weight:	*1*	*0.1*	*0.1*	*0.3*	*1*		
Option A	100	100	100	0	0	120	0
Option B	89	30	89	100	100	231	111
Option C	58	20	58	0	50	116	-4
Option C+	51	10	51	100	90	177	57
Option D	0	0	0	0	25	25	-95

A full explanation of the derivation of the scores and weights in Table 6.2 is provided below.

6.2.1. Scores

In every column the best option, against that criterion, is given a score of 100 and the worst option a score of zero.

Column 1 – Costs which can be valued

Figures are proportional to the differences in present values of measurable costs, relative to the most costly option (Option D) which is given a score of zero. The present values of total measurable costs are presented in Table 5.1. These figures comprise both the identity preservation and enforcement costs presented in Chapter 5.

Column 2 – Trade costs

On the basis that any change to the status quo is likely to cause problems with trade partners, we have allocated a score of 100 to Option A. We have assumed that the more stringent the labelling requirement the more problems that will be caused and that the difference between Option A and Option B is much larger than the differences between Options B, C, C+ and D.

Column 3 – Other costs not valued

This column represents two principle costs, the costs of diluting the information already on the food label by adding another item to it, and the costs of changes in market structure arising from the higher unit costs facing small businesses as a result of the extra costs of labelling. The costs of changes in market structure are likely to change in proportion to the size of the costs that we have been able to value (Column 1). This suggests the same scoring as in Column 1. As GM labels will be required for more food products as the labelling option moves from Option A towards Option D, this also implies a similar scoring.

Column 4 – Benefits from standardisation of "GM-free" definition

The standardised "GM-free" definition is only introduced in Options B and C+. In both cases in the "GM-free" element of the option is the same. Consequently we have given scores of 100 to Options B and C+ and 0 to the other options.

Column 5 - Benefits from restoring public confidence

The scores here depend on the likely extent to which the Option, by restoring public confidence and political acceptability, would facilitate more rapid progress towards achieving GM benefits. More stringent options might signal higher risks than appropriate. Against that, the more stringent options might do more to appease some elements of public opinion. This was the most difficult column to score.

We judge that all of the Options for change from Option A would restore confidence to some degree. We therefore score Option A at 0. Option B enables those that are most risk averse to consuming GM food to choose a "GM-free" option, where the standards are as tough as the Option D standards. Option B is also unlikely to signal higher risks than appropriate and so we have given Option B the top score of 100. We judge that Option C+ will be almost as good but there is a slightly higher risk of signalling higher risks than appropriate and so we have scored it at 90. Option C also bears that risk but in addition is less likely to satisfy those consumers that are more risk averse by offering them a standardised "GM-free" option to Option D standards. Consequently we score Option C at 50. We give Option D a lower score of 25 because there are higher risks of signalling inappropriate levels of risk to consumers and because the stricter standards of Option D are available in any case under Options B and C+ to those who wish to consume food to those standards of GM content.

6.2.2. Weights

Quantification of the *weights* to be given to these scores is more demanding and the relative weightings draw very heavily on judgement.

Because of the method of scoring, these weights are not measures of the *absolute* importance of, say, the benefits of restoring public confidence relative to cost. The weights need instead to be measures of the comparative importance of the *differences between the best and the worst*

under each criterion. Thus, for example, if all the options gave the same level of benefits of restoring public confidence, the weight to column 5 would be zero, even if restoring confidence was itself a very highly valued quality.

Column 1 – Costs which can be valued

We have given here a weight of unity to column 1 as an arbitrary baseline chosen for convenience. The value of this weight of 1 is the difference between the cost of Option A and the Cost of Option D, ie an NPV of around £1.5 billion over 20 years. This is equivalent to a regular stream of annual costs of around £130m, discounted at 6% real.

Column 2 – Trade costs

We believe that these costs, relative to Option A, are likely to be low and based only on our own judgement we have allocated a weight of 0.1 to this factor.

Column 3 – Other costs not valued

Again, we believe that these costs are likely to be low and based only on our own judgement we have allocated a weight of 0.1 to this factor.

Column 4 – Benefits from standardisation of "GM-free" definition

The weight of 0.3 that we use for this benefit was derived as follows. In response to the MORI survey of September 2000 for the Food Standards Agency, 25% of respondents said that they looked for GM information on food labels. Applying this to the UK population of about 60 million suggests that about 15 million people look for GM information on food labels. Drawing on Peters (2000)[66] we assume that each person is willing to pay about £0.15 for GM information per meal they consume. At three meals per day for 365 days, this equates to a total willingness to pay of £2.5 billion per annum. If however, only 15% of foods are labelled GM-free and the extra value of standardisation is 10% of the value of the information then the total willingness to pay is around £38 million per annum. This is equivalent to an NPV (over 20 years at 6%) of around £430 million.

Most of these figures are of course very far from rigorous. They are estimates of orders of magnitude. However any policy preference entails some trade off between these benefits and other benefits and costs. This analysis makes the trade offs explicit.

[66] This work is about the value of food meeting HACCP standards and is based on a study of only 22 respondents and so the relevance for GM is limited at best. However it does provide some indication of possible orders of magnitude for benefits.

Column 5 - Benefits from restoring public confidence

Total annual consumer expenditure on food items in the UK is about £80 billion. If we assume that total food costs will be reduced by 0.17% as a result of increasing use of GM ingredients then, over 20 years, the net present value of this saving would be about £1.5 billion. This implies a weight of 1 for this benefit, relative to column 1.

How realistic is the 0.17% assumption? Current experience on the improvement of yields from the use of GM crops appears to be mixed, though it seems likely that savings in yields will improve over time rather than get worse. Our 0.17% assumption is the same price effect[67] that we attribute to the extra segregation and traceability costs arising from Option D in our baseline scenario. Effectively, our assumption is equivalent to assuming that it is certain that public confidence will be restored and that the extra yield benefits from GM crops match the extra costs of segregation and traceability. Or, that there is a probability of 0.5 that public confidence will be restored and that the consequent benefits will be twice the cost of segregation and traceability.

Columns 6 and 7 – Weighted scores

The total weighted scores in column 6 are potentially misleading, as it is only the differences, not the absolute values which are meaningful. It is therefore clearer to express them, as in column 7, as values relative to Option A.

6.3. Adjustments to Cost Assumptions

We test here the sensitivity of our results to changes in some of the main cost assumptions. These changes affect both the weights and the scores in Column 1 of Table 6.1.

The first test relates to the level of take up of GM foods and the consequent IP costs. Our baseline case assumes that for Option D 80% of relevant food products will need some segregation in 20 years time. We tested the impact on the choice of options of assuming that take up is much more rapid, with 80% of relevant goods needing some segregation under Option D in ten years time (the percentages under the other options were also increased proportionately). The effect of this is to increase the weight for Column 1 from 1.0 to 1.1 and to change the scores for Column 1. The impact on the weighted scores of this change alone is shown as Test 1 in Table 6.2 below. The effect is very small because our base case assumes that most of the increase in costs occurs in the first ten years in any case.

The second test also relates to the rate of take up of GM foods and consequent IP costs. Our baseline case assumes that two thirds of the increase in segregation level occurs in the first ten years and one third in the second ten years. We tested the impact on the choice of

[67] Though in the opposite direction.

options of assuming that the rate of growth was linear. This assumption has the effect of reducing the net present value of IP costs and hence reducing the weight of Column 1 from 1.0 to 0.95. The scores for Column 1 also change. The impact on the weighted scores of this change alone is shown as Test 2 in Table 6.2 below.

In the third test we examined the impact on the choice of options of assuming that the rate of growth was lower in earlier years and increasing in later years, such that the rate of growth, when plotted over time could be represented by a smooth curve. This assumption has the effect of reducing the net present value of IP costs and hence reducing the weight of Column 1 from 1.0 to 0.5. The scores for Column 1 also change. The impact on the weighted scores of this change alone is shown as Test 3 in Table 6.2 below.

The fourth test relates to the overall magnitude of IP costs that we have estimated. Since the magnitude of our estimates is low relative to some of the estimates produced by others we tested the impact of increasing the weight of Column 1 from 1.0 to 5.0, whilst maintaining the scores in Column 1 at the levels in our baseline scenario. The impact on the weighted scores of this change alone is shown as Test 4 in Table 6.2 below. This increase in costs could represent a number of factors including a more rapid take up of GM foods, higher unit IP costs, higher enforcement costs, and in particular, inclusion of the costs of any legal and court actions for infringements.

Table 6.2
Weighted Scores Relative to Option A

	Option A	Option B	Option C	Option C+	Option D
Baseline	0	111	-4	57	-95
Cost test 1	0	110	-5	56	-105
Cost test 2	0	112	-2	60	-85
Cost test 3	0	117	11	77	-45
Cost test 4	0	67	-172	-137	-495

Option B maintains the highest score throughout with Option C+ ranked second except for the fourth test where it is displaced by Option A.

Since, under any plausible scenario, Option A will have the lowest IP costs of the options then it always has the highest score of 100 in column 1 of Table 6.1. Using the baseline scores for Column 1, the weight for Column 1 has to be increased to 11.2 for Option A to just become higher ranked than Option B.

Since Option B will always have the next lowest IP costs after Option A no other changes to the scores or the weight for this Column alone can lead to Options C, C+ or D having a higher weighted score than Option B.

6.4. Other Adjustments to Scores

We test here the sensitivity of the results to changes in the relative *scores* of the options in some of the other columns of Table 6.1. We focus on the one non-cost item that is most likely to affect the outcomes – the expected benefits from restoring public confidence.

We changed our assumptions for the scores attributed to the options for expected benefits from restoring public confidence as follows. We assumed that Option C+ would provide the best outcome (ie a score of 100) and that Option D would now lead to the worst outcome (ie a score of zero). Options A, B and C were allocated scores of 25, 75 and 50 respectively. This is illustrated in Table 6.3 as Test 1 and shows that Option B remains the preferred option. With these adjusted scores the weight for this column would need to rise to 1.8 for Option C+ to just become higher ranked than Option B.

We also considered what the outcome would be if increasing use of GM foods were likely to lead to net costs to society rather than net benefits. We felt that this possibility was a difficult one to consider in the context of the GM labelling options alone, as in that situation GM labelling is not likely to be the preferred policy option. Other policies such tightening controls on the use and production of GM foods are likely to be a more effective policy response. For illustrative purposes we have tested for the effects of reversing the "restoring public confidence" scores for the options such that the options most likely to deter take up of GM food is given the highest score (Option D). The effects of this change are illustrated in Table 6.3 as Test 2. Option A has the highest score because, for consistency with our base case assumptions, this is least likely to lead to restoring pubic confidence in GM foods.

Table 6.3
Weighted Scores Relative to Option A Following Score Adjustments

	Option A	Option B	Option C	Option C+	Option D
Baseline	0	111	-4	57	-95
"Restoring Public Confidence" – Test 1	0	61	-29	42	-145
"Restoring Public Confidence" – Test 2	0	-89	-104	-108	-130

6.5. Other Adjustments to Weights

Table 6.4 shows the effects of increasing or reducing the weights, one at a time, of columns 2, 4 and 5 in Table 6.1.[68] We have only tested for decreases in the weights for the two benefits

[68] Since the scores for Column 3 are the same as the scores for Column 1 the effect of changing the weight for Column 3 will be the same as the effect of changing the weight for Column 1.

columns (4 and 5) because Option B has the highest score in these columns under the baseline scenario and so its ranking will not change with any further increase.

Table 6.4
Weighted Scores Relative to Option A Following Weight Adjustments

	Option A	Option B	Option C	Option C+	Option D
Baseline	0	111	-4	57	-95
Trade Costs – increase weight to 0.5	0	83	-36	21	-135
GM-free standardisation – reduce weight to 0.1	0	91	-4	37	-95
Restoring Public Confidence – reduce weight to 0.5	0	61	-29	12	-108

Again Option B remains the preferred option, with Option C+ having the second highest scores, followed by Option A.

6.6. Alternative Scenarios

The tests described above were taken one at a time, with a separate result shown for each test against the baseline scenario. In order to show the effects of combining more than one change in assumption we have prepared two alternative scenarios. For each scenario, we have searched for the most plausible set of assumptions on scores and weights that would lead to another Option having a score as high as Option B. The two Options we chose were Option A and Option C+ as these were the options with the next highest scores in our sensitivity tests above.

6.6.1. "Option A" scenario

The full set of scores and weights we have chosen for this scenario are set out in Table 6.5 below. Since it is not plausible that Option A would score more highly than Option B on either of the two benefits columns (4 and 5), the only way for Option A to be preferred to Option B is when the magnitude of costs (as measured by the weights of Columns 1, 2 and 3) is high and/or when the costs of Option B are higher relative to Option A than in the baseline scenario (ie the score for Option B in Column 1 is lower).

Table 6.5
Scores and weights – "Option A" Scenario

	1	2	3	4	5	6	7
	Costs which can be valued £m PV	**Trade Costs**	**Other costs not valued**	**Benefits from Standardisation of "GM-free" definition**	**Benefits from restoring public confidence**	**Total weighted score**	**Weighted score relative to A**
Weight:	*3.2*	*0.4*	*0.2*	*0.3*	*1*		
Option A	100	100	100	0	0	380	0
Option B	70	30	70	100	100	380	0
Option C	58	20	58	0	50	255	-125
Option C+	51	10	51	100	90	299	-81
Option D	0	0	0	0	25	25	-355

Option A is likely to be the better option if the magnitude of IP cost is high and, in particular, if the extra costs of the GM-free option are high. Since the GM-free scheme is voluntary, and any costs of standardisation would only be those costs that are additional to the costs of the currently operated GM-free schemes, we believe this scenario is less plausible than the range of scenarios under which Option B performs best.

6.6.2. "Option C+" scenario

The full set of scores and weights we have chosen for this scenario are set out in Table 6.6 below. In this scenario the size of expected benefits from restoring public confidence has increased from the baseline (the column 5 weight has risen to 1.8); and Option C+ is more successful at restoring public confidence than Option B (the scores have changed to the values in sensitivity test 1 as outlined in section 6.3).

Table 6.6
Scores and weights – "Option C+" Scenario

	1	2	3	4	5	6	7
	Costs which can be valued £m PV	Trade Costs	Other costs not valued	Benefits from Standardisation of "GM-free" definition	Benefits from restoring public confidence	Total weighted score	Weighted score relative to A
Weight:	*1.0*	*0.1*	*0.1*	*0.3*	*1.8*		
Option A	100	100	100	0	25	165	0
Option B	89	30	87	100	75	266	101
Option C	58	20	54	0	50	156	-9
Option C+	51	10	47	100	100	267	102
Option D	0	0	0	0	0	0	-165

Option C+ is more likely to be the better option if it performs better than Option B in restoring public confidence, and if the benefits of greater penetration of GM foods are high. We believe that this is a more plausible scenario than the scenario where Option A is the best Option. However, as explained in our base case, we think that Option B is likely to perform better that Option C+ in terms of restoring public confidence. We also note that our estimates of costs are more likely to be underestimates than over-estimates and any increases in costs, lead to Option C+ looking even less attractive relative to Option B. Consequently we believe that Option B is likely to provide the best outcome.

7. DISTRIBUTIONAL IMPACTS

Box 7.1
Summary of Chapter 7: Distributional Impacts

In this Chapter we review the distributional impact of the increases in retail food prices implied by the identity preservation costs incurred as a result of the various GM labelling options.

We calculate that our base case estimates of identity preservation costs will lead to increases in average retail food prices of between 0.01 and 0.17 per cent, depending on the Option. We compare these estimates with results from other studies which tend to suggest higher average price increases, in the range 1 to 2 per cent.

By breaking down household expenditure on food across five broad food categories, and distinguishing between three levels of food processing, we estimate the distribution of the average increase in food prices across household income deciles and age bands. We conclude that richer households and households with younger heads of households will face higher increases since they consume more highly processed foods. Nevertheless, poorer households face a higher proportion of the price rise under Options C, C+ and D than they do under Options A and B.

We briefly review company size by food sector and conclude that the bread and cereals sector may face higher costs as a result of GM labelling than other sectors because of the large number of small businesses operating in this sector and because processing levels are relatively high in this sector. Further work would be needed to confirm this.

7.1. Estimating the Impact of IP on Household Food Expenditure

7.1.1. Our approach

The distributional impacts of the labelling options will depend on a variety of uncertain factors, including the take up of GM foods, the success of GM in improving yields and reducing the costs of production, the costs of identity preservation and whether consumer perceptions of the benefits vary by income or age group. Because of the uncertain nature of many of these factors and the lack of information on the distribution of consumer perceptions of the benefits, for example, we have focussed here on how the costs of identity preservation might feed through into food prices, and how those price increases will affect the expenditure on foods by various income and age bands. In practice, if GM foods are successful, the average price of foods in the long term may fall rather than rise. Even if this is the case, the group of consumers who oppose the use of GM foods on ethical grounds will be adversely affected.

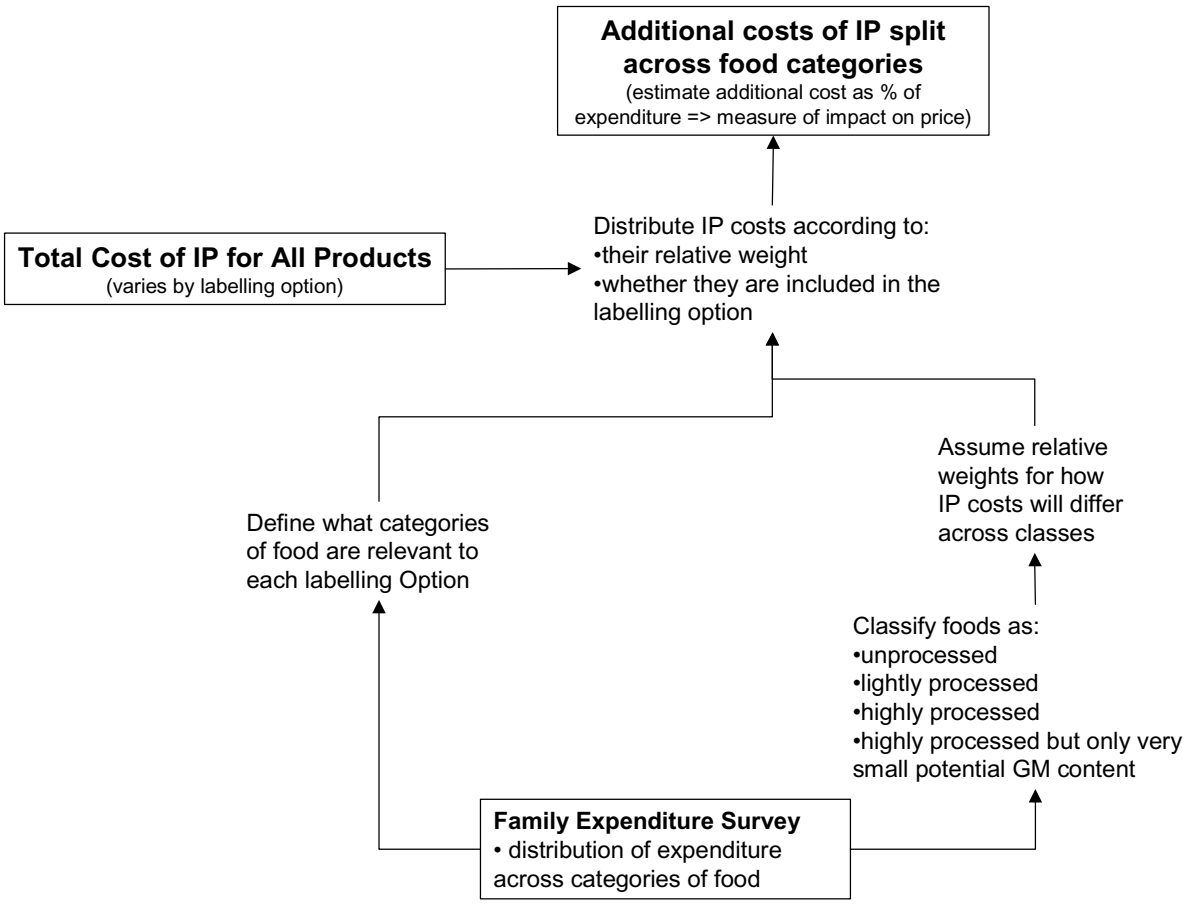
In order to estimate the likely distributional impact of increases in prices arising from increases in IP costs our starting point is to compare estimates of UK consumption of food

(taken from the Family Expenditure Survey, which breaks down expenditure by broad groups of food) with our estimates of total IP costs. Figure 7.1 illustrates our approach to doing this. However, to estimate the potential price impact on specific types of foods, these IP costs need to be distributed across food groups. To do this, we have taken a two stage approach, as follows:

- We have defined which foods will incur IP costs under each Option. Not all foods are relevant to all Options.
- We have categorised the food groups in the Family Expenditure Survey according to their level of processing (we have done this categorisation ourselves, but it is based on a breakdown used by MAFF when presenting their import data (used in the previous step)). Three categories are generally used; unprocessed, lightly processed and highly processed. To this we have added a fourth where the product is highly processed but will only contain a small amount of a GM crop. Our hypothesis is that IP costs will differ according to the degree of processing (more processing implies a higher IP cost).

The total costs of IP are then distributed across different categories of food depending on a) whether they are relevant to the labelling option being considered and b) their degree of processing.

Figure 7.1
Estimating the Impact of IP on Food Prices



To do this, we have had to make assumptions about how IP costs differ according to the degree of processing. Our estimates of total IP costs - i.e. the per unit segregation costs – are averages and will differ across products. This is somewhat arbitrary and we have found no information to indicate how the costs might differ across products. We have therefore devised a simple weighting system to distribute our estimates of total IP costs across individual food types. Table 7.1 shows the weighting and provides some examples.

Table 7.1
IP Weightings by Processing Level

	Unprocessed	Lightly processed	Highly processed	Highly processed but low GM content
Weight	0	1	3	1.5
Example foods	Fresh food, vegetables & potatoes	Uncooked meat, milk & eggs	Breakfast cereals, cooked meats, ice creams	Bread, jam, jellies, preservatives

The category "highly processed but low GM content" includes foods that have been defined as highly processed but where the total amount of GM (or potentially GM) content is low. This includes products, for example, that contain some GM food additives, but very little soya / maize etc. These products will still incur IP costs, but we believe that they will be less than if the product could contain a significant amount of GM DNA or protein. Arbitrarily, we have assumed that the relative IP costs for these products will be half what they are for "highly processed" products.

7.1.2. Current expenditure by income and age bands

Figure 7.2 shows the proportion of weekly household expenditure accounted for by food and non-alcoholic drinks by income decile. As expected, it shows that poorer households spend proportionately more on food than richer households, with food and non-alcoholic drinks accounting for 20% or 21% of expenditure for the lowest three income deciles, falling to 14% for the highest income decile.

Figure 7.2
Percentage of Household Expenditure on Food and Non-Alcoholic Drinks by Income Bands

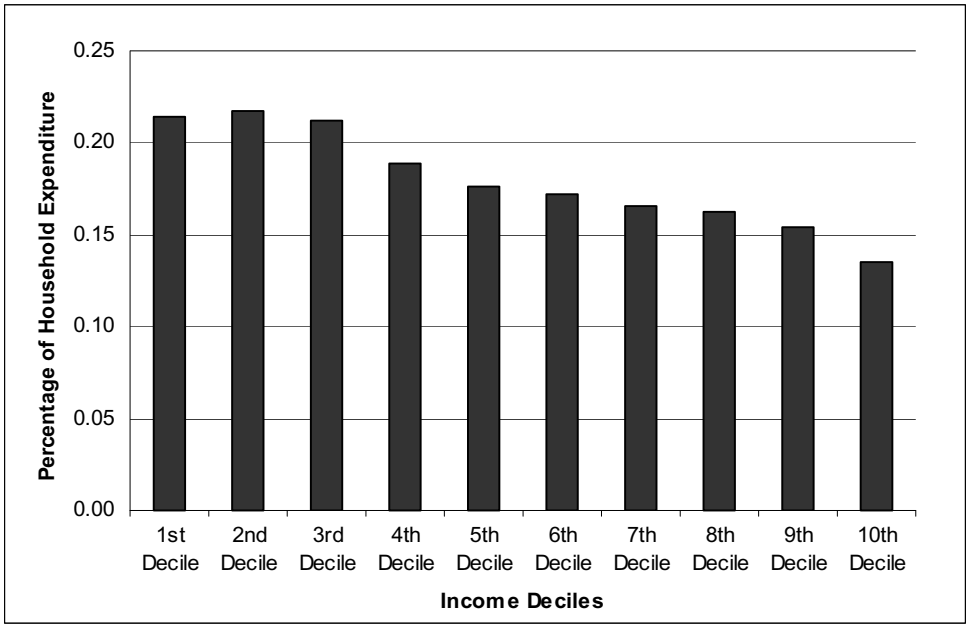
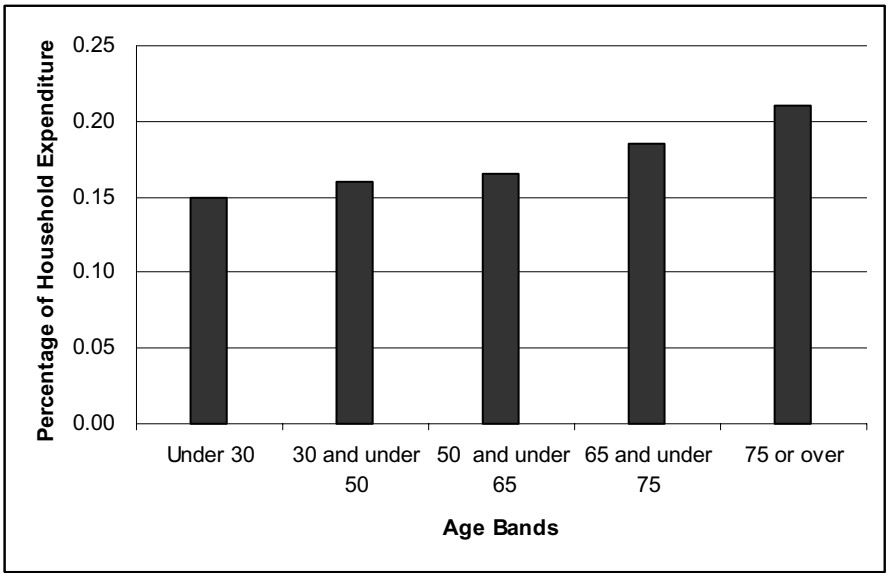


Figure 7.3 shows the proportion of weekly household expenditure accounted for by food and non-alcoholic drinks by age group.

The table shows that households with older heads of household spend proportionately more on food than younger households, with food and non-alcoholic drinks accounting for 21% of expenditure for those in the 75 years or over band, falling to 15% for the youngest age band. Much of this difference may be accounted for by a correlation between older households and lower incomes, though this may not be the case at the younger end of the age scale.

Figure 7.3
Percentage of Household Expenditure on Food and Non-Alcoholic Drinks by Age of Head of Household



7.1.3. Increase in expenditure resulting from GM labelling costs

We have tested the effects of food price increases on these proportions of expenditure for households, both by income decile and age band.[69] The FES data is provided at detailed food product levels and we have aggregated this data into our five food categories - Bread and Cereals; Meat, Fish and Dairy Products; Fruits and Vegetables; Non-Alcoholic Drinks; and Other Highly Processed Foods.

For simplicity, and because there is some evidence to support the assumption, we have assumed that all increases in costs resulting from GM labelling requirements ultimately feed through wholly to consumer prices. This assumption is consistent with the findings of a study undertaken by MAFF and academic partners on the relationship between producer, wholesale and retail prices of beef, lamb and pork.[70] The main conclusions included:

- "*meat price changes (both increases and decreases) are fully or largely transmitted through the supply chain from producer to retail;*

[69] More detailed analysis by household composition (e.g. two-pensioner households) would be possible using unpublished FES data should the FSA wish to pursue this in the future, though this has not been feasible within our timescale.

[70] MAFF (1999).

- *however, there are lags in the system and these adjustments typically take several months to work through the chain…….*"

This study was submitted to the Competition Commission during their review of Supermarkets.[71] The Competition Commission review covered the supply of grocery products through supermarkets and so related to more than just meat products. One of their conclusions was that changes in cost do tend to be transmitted into retail prices:

"*We looked at whether the recent declines in wholesale prices, especially in the livestock sector, were being fully reflected in retail prices charged to consumers in reference stores. This stemmed from complaints that price cuts suffered by UK farmers during 1997/98 had not been fully reflected in corresponding falls in supermarket prices. We were satisfied that cost reductions at the farm gate had either been passed through to retail prices or, where they had not, that there had been cost increases elsewhere in the supply chain. In a competitive environment, we would expect most or all of the impact of various shocks to the farming industry to have fallen mainly on farmers rather than on retailers; but the existence of buyer power among some of the main parties has meant that the burden of cost increases in the supply chain has fallen disproportionately heavily on small suppliers such as farmers.*"[72]

To illustrate the effect of prices on demand, the own price elasticity of demand is used for products for which data is available. For example, the own price elasticity for uncooked pork is –0.93 according to the National Food Survey (1999). This means that a 10 percent increase in its price would decrease the demand by about 9 percent. Therefore small price variations in the price of uncooked pork leave the expenditure almost unchanged. However own price elasticity data is restricted to meat, meat products and fish, which is available in the National Food Survey and Tiffin and Tiffin (1999). However, we expect this to have a limited effect on the result as the National Food Survey and other studies such as Tiffin and Tiffin (1999) suggest that aggregate food demand in the UK is price inelastic and most individual food categories, except meat and fish, are price inelastic i.e. their own price elasticities are close to zero, which means that a change in price does not alter demand and, therefore, the expenditure rises by an equivalent ratio.

Overall, an average UK household spends about £57 weekly on food and non-alcoholic drinks. If GM labelling requirements were to be introduced, then our base-case analysis suggests that expenditure on food and non-alcoholic drinks would increase between 0.01 per cent to 0.17 per cent, depending on the labelling option. This is illustrated in the Table below.

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71 Competition Commission (2000).

72 We note however that the Competition Commission did conclude that there was evidence of market power in some parts of the industry and that this did act against the public interest.

Table 7.2
Average increases in Household Expenditure on Food in the Base Case

	Option A	Option B	Option C	Option C+	Option D
Expenditure increase	0.01%	0.03%	0.08%	0.09%	0.17%

These increases are lower than the limited number of other estimates of retail food price increases arising from GM labelling that we have seen.

The KPMG Consulting (2000) study for Canada estimates that labelling will add approximately 1.3 per cent to 1.8 per cent to the value of retail sales of all food products compared to our figure for Option D (the most comparable standard) of 0.17 per cent on all foods. As we have not seen the full detail of those calculations it is difficult to be clear about the precise reasons for the disparity, but there are a number of possible reasons.

- First, KPMG have used higher unit IP cost estimates: 34-39 dollars per tonne for corn and 47-52 dollars per tonne for soyabeans, compared to ours estimate of 22 euros (about 20 dollars) per tonne for corn and 32 euros (29 dollars) per tonne for soya. The KPMG estimates include some costs which we have not included,[73] but the difference is probably mainly due to different sources of information. For the farmer and elevator stages, they have only one source, which gives a relatively high estimate of the costs. They base the manufacturing and processing stages on interviews with industry experts and come up with a similar cost to us, but then include manufacturing and processing as separate stages, which raises the total cost.
- Second, KPMG take a different approach to aggregating the unit costs across the industry. Rather than looking at the amount of crop which will require segregating, they assume that 70-85 per cent of processed foods are subject to labelling and will incur these costs. We have assumed however that smaller proportions of processed foods derived from wheat, maize, soya and oilseed rape will need labelling since many supply chains may be restricted to GM or non-GM ingredients only.
- Third, lower food prices in Canada may mean that even for similar IP costs percentage increases in price will be higher.

The KPMG (2000) report on New Zealand and Australia suggests price increases of 0 per cent to 6 per cent for different types of food, but give no overall increase in the retail price of food. Comparison with our result is also difficult as the costs are not broken down into unit costs per tonne and we have seen little explanation of the derivation of this figure.

[73] For example, they include the cost of increased use of fertilizer for non-GM crop, but we have not included this as it is a cost of non-GM food rather than labelling. They also include a 2 dollar per tonne cost for redesigning labelling, which is not included in our estimates of segregation costs.

We understand that a recent study for Sainsbury, MAFF and the NFU suggests that the impact of IP costs on the value of meat products may be in the range of 1 per cent to 2 per cent (where the tolerance level is 1 per cent). We do not have access to sufficient detail to explain the differences with our results.

7.1.4. Increase in expenditure by food category

Table 7.3 shows the implied increase in expenditure on lightly and highly processed foods for each of the options under the base case. It also shows that total household expenditure on food under Option D increases twice as much as it does under Option C and seventeen times as much as it does under Option A.[74]

Table 7.3
Implied Increase in Expenditure on Lightly and Highly Processed Foods

OPTION	Increase in Expenditure on the Lightly Processed Foods and Non-Alcoholic Drinks[75]	Increase in Expenditure on the Highly Processed Foods and Non-Alcoholic Drinks	Average increase in Expenditure on all Foods and Non-Alcoholic Drinks
A	0.007%	0.022%	0.010%
B	0.019%	0.058%	0.027%
C	0.043%	0.129%	0.075%
C+	0.049%	0.148%	0.086%
D	0.085%	0.255 %	0.166%

Apart from fruits and vegetables all other food categories that we have defined contain some processed foods.[76] Each of the other categories contains a variable mix of highly and lightly processed goods and so prices for each category rise by varying degrees. Categories with a higher proportion of highly processed goods face a steeper increase in prices. Table 7.4 shows that the expenditure on meat, fish and dairy products and non-alcoholic drinks rises by a much smaller margin compared to bread and cereals and the "other highly processed foods" category which contain a relatively higher share of highly processed goods.[77] Note that the expenditure on meat, fish and dairy products rises by a much smaller proportion

[74] The increase in the price of individual goods is always higher under option D than under options A and C. This is because, first, more products are affected under option D than under options A and C and, second, for many products the increase in cost is higher under option D than A or C because under this option manufacturers have to trace the origins of animal feed and processing aids and have to keep a longer IP trail.

[75] Note that the increase in the price of lightly processed foods is 1/3 the increase in the price of highly processed foods as we assumed in the model.

[76] See Appendix C for further details of the foods in each of the five categories.

[77] For example, expenditure on meat, fish and dairy products rises only 0.41 times the average expenditure increase, whereas expenditure on bread and cereals rises by 1.2 times the average expenditure increase.

even compared to non-alcoholic drinks which has almost the same proportion of highly processed goods. This is because meat, fish and fish products are price elastic and even though their price rises proportionately, the amount of quantity consumed goes down slightly and therefore expenditure rises by a lesser amount. Moreover, this trend is consistent throughout all options.

Table 7.4
Increase in Expenditure Across Different Food Categories Relative to Average Overall Increase

Category	Proportion of Highly Processed foods	Option A	Option B	Option C	Option C+	Option D
Overall	**0.63**	0.010%	0.027%	0.076	0.087	0.166
Indexed		**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
Bread and Cereals	**0.67**	1.42	1.42	1.13	1.13	1.20
Meat, Fish and Dairy Products	**0.28**	0.19	0.19	0.15	0.15	0.41
Other Highly Processed Foods	**0.99**	1.59	1.59	1.69	1.69	1.53
Vegetables	**0.00**	0.00	0.00	0.00	0.00	0.00
Non-Alcoholic Drinks	**0.33**	0.88	0.88	0.77	0.77	0.85

The relative increase in price under option B is similar for all categories to the increase in price under option A. This is because the basket of products included under option B is the same as option A. Although not noticeable at the two decimal level, the increase in expenditure for the meat, fish and dairy products is 1/1000 less compared to other food categories because the own-price elasticity effect discussed earlier. For similar reasons, the relative increase in price across different categories under option C+ is similar to option C, apart from the meat, fish and dairy products category.

The basket of food products included under options A, C and D varies. The number of products included in option D is greater than the number of products included under options C, which is greater than the number of products included under option A. This has implications for the proportionate increase in expenditure of households across different categories under different options. For example, since uncooked meat is included under option D but not in any other option, the increase in expenditure on the meat, fish and dairy category under option D is several times more than in other options. This trend is consistent across different food categories, although the extent of increase in expenditure fluctuates considerably, and is illustrated in Table 7.5.

Table 7.5
Relative Increase in Expenditure Across Different Labelling Options Compared to the Average Increase in Expenditure Under Option A.

Category	Option A	Index	Option B	Option C	Option C+	Option D
Overall	0.010%	**1.00**	2.64	7.34	8.41	16.09
Bread and Cereals	0.015%	**1.00**	2.64	5.86	6.71	13.53
Meat, Fish and Dairy Products	0.002%	**1.00**	2.64	5.85	6.70	34.98
Other Highly Processed Foods	0.016%	**1.00**	2.64	7.79	8.92	15.45
Vegetables	0.000%	**1.00**	1.00	1.00	1.00	1.00
Non-Alcoholic Drinks	0.009%	**1.00**	2.64	6.49	7.43	15.64

7.1.5. Increases in expenditure by income and age bands

Comparing the overall increase in average expenditure in our base-case across households shows that expenditure grows more for the highest income decile and ranges between 0.12 per cent and 0.18 per cent for different options compared to the lowest for which it ranges between 0.01 per cent and 0.15 per cent. Similarly the increase is more for households with a younger head (0.01 per cent to 0.19 per cent) than an older (0.01 per cent to 0.14 per cent). The reason for this is that richer households and households with a younger head tend to spend more on highly processed goods as shown in Table 7.6. Since the price of highly processed foods is assumed to grow faster than the price of other foods, the average expenditure for these households grows more than that of the households with less income and older heads.

Table 7.6
The Share of Average Weekly Household Expenditure on Unprocessed, Lightly Processed and Highly Processed Products for the Extreme Income Deciles and Age Groups.

Processing level	Share of average weekly household Expenditure on food and non-alcoholic drinks.			
	Lowest income decile	Highest income decile	Over 75 head of the household	Under 30 head of the household
All goods	**1.00**	**1.00**	**1.00**	**1.00**
Highly Processed	0.61	0.72	0.60	0.74
Lightly Processed	0.25	0.18	0.25	0.17
Unprocessed	0.14	0.10	0.15	0.09

An important impact of these labelling options on the increase in expenditure is the relative impact of price increases across households. The results of our analysis show the spread between the increase in prices for households in the highest and the lowest income decile, and between households with the youngest and oldest heads of household vary under each option. Table 7.7 shows that this spread is greater under options A and B compared to options C, C+ and D. Under Option A the price increase for the highest income decile is 48% more than the price increase for the lowest income decile. Similarly, the price increase is 56% more for the youngest head of household category compared to the oldest head category. Thus the least expensive options, A and B, tend to lead to higher income households being faced with a relatively higher proportion of the costs of IP than lower income households. As the more expensive options result in cost increases for a wider range of lightly processed and unprocessed foods, the spread of average price increases for the extreme income and age groups is much lower under Option D. This leaves the lower income and older groups facing proportionately higher food costs under Option D than they do under lower cost options.

Table 7.7
The Spread of Average Increase in Price for the Extreme Income Deciles and Age Groups.

Option	Highest and lowest income decile (Multiples where lowest income decile =1.0)	Youngest and oldest head of household (Multiples where youngest age band =1.0)
A	1.48	1.56
B	1.48	1.56
C	1.31	1.40
C+	1.31	1.40
D	1.22	1.31

Available data for price elasticity of demand of meat and fish is at an aggregate level, and not for separate household income and age bands. Care is needed in interpreting the analysis for income deciles and age groups. For example, one would expect the demand for meat and fish of the lowest income decile to be more price-sensitive than the highest ones, for two reasons. First, for the poor households the marginal disutility of the increase in expenditure due to a rise in prices is more than that for higher income households. Second, the income effect forces poor households to shift from using the relatively expensive foods like meat, to less expensive foods that also meet their needs. Consequently, due to a reduced demand for meat and fish, the expenditure of households in the lowest income decile may increase by a much smaller amount than suggested by our current results. Equally, since households with a pensioner as a head are expected to be more price-sensitive, the rise in their expenditure may also be less than suggested by our current results. We have been unable to find evidence on food price elasticities by income or age bands. However, whilst this data might change our estimates of the overall magnitude of the

impact of labelling on price across different options, it would be unlikely to change the relative distributional impacts of the options.[78]

Our assumption that total household expenditure remains constant also inflates the forecast share of food and non-alcoholic drinks in total household expenditure by a small margin. An increase in the price of food and non-alcoholic drinks may increase the overall average weekly expenditure of some households, altering their consumption patterns, and reducing the share of food and non-alcoholic drinks.

For illustration, we show in Table 7.8 the effect on average price rises by food category of a fivefold increase in the IP costs of the options. This matches one of the sensitivity tests we undertook in Chapter 6 and shows that even under Option D (which leads to the highest costs) the average price increase would be less than one per cent.

Table 7.8
Prices for Different Labelling Options with Fivefold Increase in IP Costs.

OPTION	Increase in Price for the Lightly Processed Foods and Non-Alcoholic Drinks	Increase in Price for the Highly Processed Foods and Non-Alcoholic Drinks	Average Price Rise for all Foods and Non-Alcoholic Drinks
A	0.04%	0.11%	0.05%
B	0.09%	0.29%	0.14%
C	0.22%	0.64%	0.38%
C+	0.25%	0.74%	0.43%
D	0.43%	1.28%	0.83%

7.2. Impact of IP on Small Businesses

A number of commentators have suggested that increases in food supply chain costs are more likely to have a large impact on small businesses than they are on larger businesses.[79] There is also a wider concern in Government about the impact of regulation more generally on small businesses. The Better Regulation Task Force has examined ways of reducing the

[78] We also note that if the prices of all or most foods rise, rather than the price of individual foods or food categories, then the price elasticity effect may be lower.

[79] This includes the Competition Commission (2000) comments noted earlier, Golan, Kuchler and Mitchell (2000), and KPMG (2000).

impact of regulation on small businesses[80] and has also considered more specifically the impact of regulation, including GM regulation, on the hotel and restaurant sector.[81]

The extent of the impacts on small business from GM labelling is difficult to gauge, with the distinction between the labelling requirements under the different Options even more difficult to judge. It does seem likely that the costs will be higher for the options with tighter standards, largely because they will impact on a wider range of food products.

Some useful academic research has been undertaken on the impacts on small businesses of food regulation.[82] This work, based on surveys of businesses, gives an indication of the extent to which compliance costs are quantified by businesses, the problems with complying with food safety regulation and the types of compliance cost that are incurred. Although this work does not provide us with "easy" numbers to pick out for the purposes of our study it does provide a useful starting point for more detailed original research on the compliance costs of food regulation.

Figure 7.4 below shows the data on numbers of companies in various food sub-sectors classified by company size (as measured by turnover) that is available from National Statistics.[83] It shows the bread and cereals sector with lots of smaller companies at one end of the scale, and the non-alcoholic drinks sector with a relatively small number of large companies at the other end. When compared with the data presented in Table 7.4 in the

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80 Better Regulation Task Force (April 2000).

81 Better Regulation Task Force (June 2000). The conclusion on GM labelling requirements in restaurants was that they "are arguably unenforceable and there is little evidence of consumer concern".

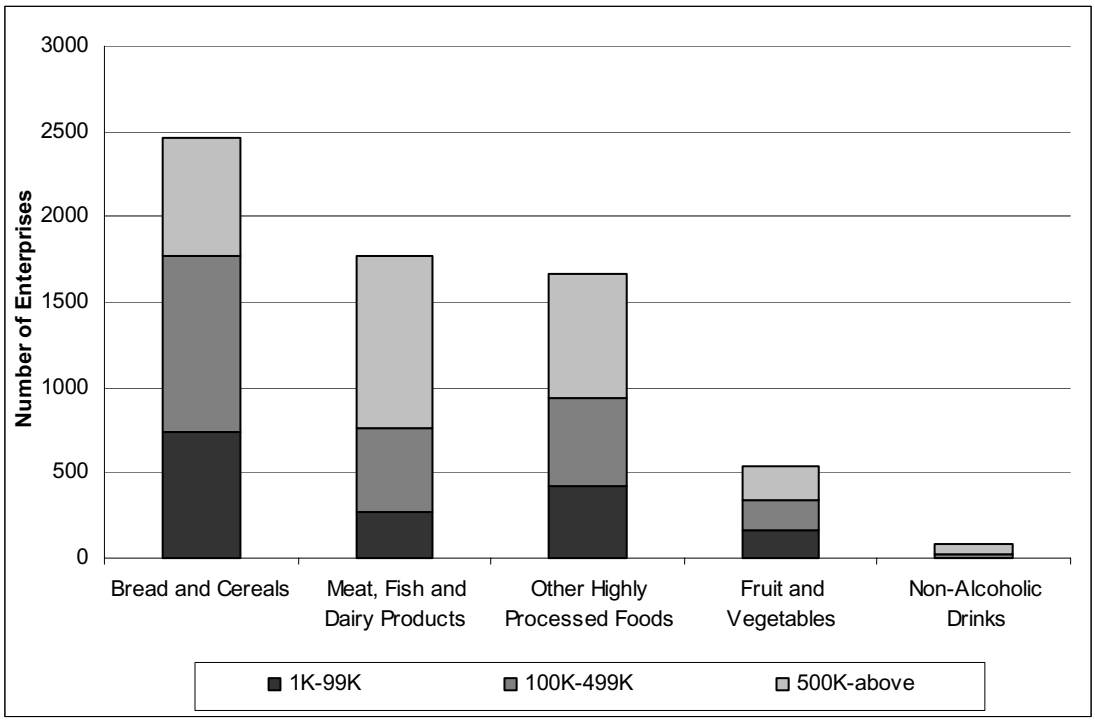
82 Heasman and Henson (1997); Henson and Heasman (1998) and Henson, Holt and Northen (1999).

83 Our classification of food categories and the SIC codes of each product as presented in National Statistics (2001).

	Bread and Cereals		**Other Highly Processed Foods**
15.81	Bread; fresh pastry goods and cakes	**15.41**	Crude oils and fats
15.82	Rusks and Biscuits; preserved pastry goods etc	**15.42**	Refined oils and fats
15.84	Cocoa confectionery etc	**15.43**	Margarine etc.
	Meat, Fish and Dairy Products	**15.52**	Ice cream
15.11	Production of meat	**15.61**	Grain mill products
15.12	Poultry meat	**15.62**	Starches etc
15.13	Meat and poultry meat products	**15.71**	Prepared feeds for farm animals
15.2	Processing and preserving of fish and fish products	**15.72**	Prepared pet foods
15.51	Operations of dairies and cheese making	**15.83**	Sugar
	Fruits and Vegetables	**15.85**	Farinaceous products
15.33	Fruit and vegetable NEC	**15.87**	Condiments and seasonings
15.31	Potatoes	**15.88**	Homogenised and dietetic foods
	Non-Alcoholic Drinks	**15.89**	Other food products
15.32	Fruit and vegetable juice		
15.86	Tea and coffee		
15.98	Soft drinks and mineral water		

previous section it can be seen that the bread and cereals sector, with the highest number of small businesses is also likely to experience one of the higher increases in IP costs. This suggests that the problems for small businesses may be higher in this sector than in others.

Figure 7.4
Number of Enterprises by Turnover Band (£) and Food Group



8. CONCLUSIONS

8.1. Our Results

Our approach has been to take a relatively simple multi-criteria analysis framework for assessing the options. Using existing evidence where available, we show how alternative assumptions affect the outcome in terms of the relative positions of the options. This approach forces the appraiser to be transparent about all the assumptions and trade-offs inherent in the appraisal. Given the wide uncertainties associated with any appraisal of options for GM labelling, most readers are likely to disagree with at least some of the assumptions that we have used. However we hope that the framework we present enables readers to judge the impact of using their own preferred assumptions. Based on our framework and on available evidence, we indicate which option we believe provides the best balance of costs and benefits.

We do not suggest that any one set of assumptions that we have used should be treated as a forecast of the take-up of GM foods or of the costs and benefits of labelling for GM content. A great deal of further work, using more sophisticated models of the agri-food sector would be required for detailed forecasts. Although our approach is not intended to provide a robust forecast of future levels of costs and benefits, we believe that our work provides a strong indication of the relative merits of each of the options. [84]

The results of our comparisons of the costs and benefits of the options are presented in Chapter 6. Our base case estimates of costs are low relative to some other estimates of GM labelling costs that we have seen. Probably the main factors driving these low estimates are our assumptions that take up of GM food will be relatively slow over the next 20 years and that the number of crops that have useful GM varieties will be limited – our analysis has focussed on soya, maize, rapeseed and wheat.[85] Nevertheless, our estimates suggest significant costs particularly for Options C through D.

We find that one of the options associated with lower costs, Option B, is favoured over higher cost options such as Options C and D. The principle reason for this is that our views about the benefits of the options suggest that the extra costs of moving towards the more stringent GM labelling standards outweigh the extra benefits that can be achieved. This means that even if we change our assumptions about the overall magnitude of GM costs and increase them to much higher levels, Option B is still preferred to the higher cost options.

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[84] Suggestions for how this work could be strengthened are included in the next section.

[85] Although this is a limited number of crops these crops or their derivatives are present in a very large part of the food consumed and so their impact on segregation and other costs will be very large compared to many other crops.

Option B and, to a lesser extent option C+, perform well for two reasons. First, because it is only these options that provide the benefits that can be derived from standardising the definition of “GM-free"; and second, because they are likely to perform better in terms of restoring public confidence. This is because they provide a choice of a stringent standard for those consumers who wish to purchase goods to that stringent standard and also because they are less likely to send possibly misleading signals about the risks of GM foods to those consumers who legitimately do not currently have a strong aversion to GM food. Option A performs well relative to Options C and D because although its contribution to benefits is not high, it has much lower costs.

We have tested the robustness of the conclusion that Option B provides the best balance of costs and benefits, by preparing two alternatives to the baseline scenario. These show the changes in assumptions necessary for Options A and C+, in turn, to become the highest rank options.

Option A is likely to be the better option if the magnitude of IP cost is high and, in particular, if the extra costs of the GM-free option are high. Since the GM-free scheme is voluntary, and any costs of standardisation would only be those costs that are additional to the costs of the currently operated GM-free schemes, we believe this scenario is less plausible than the range of scenarios under which Option B performs best.

Option C+ is more likely to be the better option if it performs better than Option B in restoring public confidence, and if the benefits of greater penetration of GM foods are high. We believe that this is a more plausible scenario than the scenario where Option A is the best Option. However, as explained in our base case, we think that Option B is likely to perform better that Option C+ in terms of restoring public confidence. We also note that our estimates of costs are more likely to be underestimates than over-estimates and any increases in costs, lead to Option C+ looking even less attractive relative to Option B. Consequently we believe that Option B is likely to provide the best outcome.

As we discuss in Chapter 4, we do not believe that there is a strong likelihood of any of the options having a large impact on public confidence. Consequently the dampening effect that Option D would have on consumer confidence relative to the position under, say, Option B will be very limited. In our view, the most appropriate policy response to the environmental risks and to ethical concerns is not to change GM labelling policy by, say, moving from Option B to Option D, since that will achieve little or nothing, but to maintain careful controls on the introduction of GM crop varieties, to ensure that researchers are able to further our understanding of the impacts of GM use and to develop public sector “risk communication” in this field. The extent of these other policies is obviously an important issue, but it is beyond the scope of this study.

Our assessment is that the impacts of the costs of identity preservation on food prices for final consumers will be relatively low, largely because these costs only form a small part of total costs for food production and distribution. Higher income households and younger

households are likely to face the highest increases in expenditure because they tend to consume more processed food. The impact on small businesses is much more difficult to assess, but the combination of high IP costs and large number of small businesses may have a particular impact in the bread and cereals sector. The GM labelling options with the higher costs will impact most on low income and older households and on small businesses.

8.2. Scope for Further Work

The further work that may be desirable is of two types:

- Improving the modelling of the agri-food sector;
- Improving the assumptions that are fed into any model.

Our approach to modelling the sector was simplistic in order to meet time and budget constraints. The more sophisticated models of the agri-food sector that must already exist could improve the robustness of our estimates, particularly with regard to the levels of future costs (and benefits) and the potential for future take-up of GM foods. We would expect their contribution to improving the robustness of the conclusion on Option choice (the key purpose of our work) to be more limited however.

Improving modelling assumptions is likely to make the greater contribution to improving decisions on the choice of options. In our view the priority should be to further understand the views of consumers in two principle respects. What is it that would raise their levels of confidence in GM foods, and in particular how would the different options fare on this score - is Option B sufficient? How do consumers read food labels, which types of information, in terms of both form and content are most useful to them? At what point is more information, too much information? Useful information of this sort is most likely to be derived from sophisticated long term consumer research studies.

On the cost side, there are many examples throughout our report where it is clear that more information would be useful. Perhaps one particularly useful point would be to understand how much more costs need to be incurred for GM identity preservation systems where other IP systems already exist. Are there any additional costs from beef IP for GM purposes, for example, if extensive IP is to be required for other purposes? We have seen little information about how the level of enforcement effects the level of compliance with food standards – further investigation in this area might contribute to understanding the extent to which the potential benefits of GM might be realised and how much it could cost to enforce that. There is also considerable scope for more detailed assessment of the trade implications of the various options.

APPENDIX A. THE TERMS OF REFERENCE FOR THIS STUDY

Economic appraisal of options for extension of legislation on GM labelling

Background

1. The Food Standards Agency (FSA) is charged with the primary aim of protecting the health of the public and the interests of consumers in relation to food. It is required by statute to take into account the costs and benefits of its decisions and to make its decisions in an open and transparent manner.

2. At its 4th meeting on September 21st 2000, the FSA Board reviewed food labelling in general and considered whether further legislation might be required for GM labelling in particular. The Board recognised that before it could make a judgement on this issue however, it needed more information on both the feasibility of implementing and enforcing more comprehensive regulations and on the magnitude and incidence of costs and benefits of the options for doing so.

3. The issue has recently assumed more urgency and importance as the European Commission (EC) is currently considering draft proposals on this issue. If the UK is to have a chance of influencing the final decision, its arguments must be marshalled speedily.

The options

4. There are 4 main options for extensions to the current labelling régime under discussion, which - very briefly - are:

(A) Maintaining the Status Quo

(B) Maintaining the Status Quo and introducing a "GMO-free" line

(C) Labelling of all foods derived from GMOs

(D) Labelling of all products produced with the help of GMOs

5. The Commission is focussing on option C at present, although several member states favour option D. A few member states support option B.

6. Whatever rules are agreed for food products will then be proposed for animal feed labelling as well. However, there are also calls from some to label meat and other foods derived from animals fed on feed containing GM ingredients.

7. Each of the options has different associated implications for monitoring and enforcement methods. Options C and D for example imply quite burdensome

additional traceability procedures for food producers to comply with. Although the FSA is aware of an Australia/New Zealand study on the subject (attached), reliable information on the compliance costs for food producers - both short and long-term - of the alternative regulatory regimes under consideration seems to be unavailable at the moment. In addition, the impact of a stricter labelling regime on new product development is largely speculative. The ultimate incidence of any additional economic costs of the proposed regulations is also largely unknown - i.e. whether any additional production costs bear most on the food producers, processors or retailers or on consumers in the UK.

8. No attempt has been made as yet - as far as the FSA is aware - to measure or value the benefits achievable under each option. The benefits of a stricter labelling regime are likely to be mainly in terms of consumer choice - i.e. consumers may place a value on being able to choose to avoid foods containing GM ingredients with greater confidence.

9. In the light of this background and the many knowledge gaps identified, the FSA wishes to commission an economic appraisal of the options for changes to the regulations on GM labelling - and the consequent introduction of traceability requirements - with the following terms of reference, deliverables and timetable:

Terms of Reference

10. To provide an economic appraisal - using HM Treasury 's *Green Book* methods - of the options for extending the regulations on GM labelling and associated implications of introducing a traceability requirement in time to inform the May 2001 meeting of the FSA Board. The appraisal should make best use of any extant information from available studies or - where appropriate - make estimates from information available from other contexts. Some small-scale special surveys to supplement the information available should be considered, subject to time constraints.

11. The appraisal should clearly identify:

- The principal costs, benefits, risks and uncertainties associated with each option;
- Values which can be derived for the costs and benefits, together with their sources. Attempts should be made to provide physical magnitudes for those costs or benefits which cannot be valued;
- The estimated short and longer-term incidence of the identified costs and benefits, in particular:
  - on UK consumers in the main income and demographic groups;

- on UK producers of various scales (e.g. large and small farmers/ animal feed manufacturers);
- on UK producers at various points in the food chain (e.g. farmers, feed manufacturers, food processors, food retailers and catering establishments); and
- on UK taxpayers.

- Any novel economic issues encountered in the appraisal process and how handled; and
- Further research that might be usefully carried out in the future to reduce some of the key uncertainties in the appraisal.

Deliverables

12. In line with the requirement of the FSA Board to receive some estimates (even with significant uncertainties involved) as early as possible, consultants should produce 2 reports:

- an early appraisal, setting out the framework for analysis, the knowledge gaps still to be filled and the key areas of uncertainty, but using provisional estimates of key magnitudes; and
- a more considered appraisal - of publishable quality - with as many as possible of the uncertainties about estimates in the early appraisal report reduced.

APPENDIX B. COST ESTIMATES FROM OTHER STUDIES

There are several studies examining the costs of identity preservation, which, in addition to shorter articles and discussions with industry professionals, form the basis of our estimates for segregation costs. Table B.1 gives an overview of the main studies, showing which country they relate to and the areas which they focus on. They are discussed in more detail below. For ease of comparison we have converted the study cost estimates into Euros using market exchanges rates on 16 March 2001.

Table B.1
Previous Studies Quantifying Costs of Labelling or IP

	EC DGVI	Buckwell et al.	Sains-burys et al.	House of Commons	KPMG	KPMG/Uni. of Guelph	Ben-der et al.	Malts-barger et al	Clarkson
Country	**Various**	**Various**	**UK**	**UK**	**NZ/Aus**	**Canada**	**US**	**US**	**US**
Seed Provider	○		○						○
Farmer	○	○	○	○		○			○
Grain Elevator / Handler	○	○	○	○		○	○	○	○
Processor / Manufacturer	○	○	○	○		○			○
Retailer						○			○
Total Costs	○	○	○	○	○	○			○
Regulatory Body	○	○			○				
Trade Impacts					○				
Environment									

The European Commission Directorate General for Agriculture have produced a working paper[86] which takes a wide view of the economic impacts of GMO's on the agri-food sector. In particular, it contains a section on labelling which discusses the costs involved and gives some empirical examples of the costs of IP at various stages of the supply chain, most of which are taken from the other published material mentioned in this section. Based on these examples, they give a range of €5 - €25 per tonne for the total costs of IP, depending on the crop and the IP system. In addition to the costs of IP, the report also discusses the distributional impacts and the trade dimension but does not attempt to quantify these issues.

One of the papers on which the EC report bases its estimates is a study by Buckwell et al. on the economics of IP.[87] In addition to a lot of useful discussion on the subjects covered in this paper, the report also contains estimates of the IP costs for several case studies of GM crops

[86] European Commission Directorate General for Agriculture (2000).

[87] Buckwell et al (undated).

(eg maize, soya beans and oilseeds). Their examples range from €14 – €30 per tonne, depending on the extent of the IP and the nature and size of the market, although they stress that it is difficult to generalise the costs. They also emphasise that there may be a tendency for those who are unconvinced of the need to undertake IP to overstate the magnitude of the costs and that the costs are likely to change as the industry learns how best to organise IP and as the volume of material involved increases.

A recent study undertaken for Sainsbury, the NFU and MAFF looks at the cost of providing GM-free animal feed. This quantifies the additional costs under Option D. However, since the costs of segregating animal feed may be similar to the costs of segregating crops destined for use in human food, at least up until the processing stage, it is also relevant for more general segregation costs. Our discussions suggest that the costs depend delicately on the tolerance level for contamination, with the retail price of meat being virtually unaffected at the 5 per cent tolerance level, increasing by 1-2 per cent at 1 per cent tolerance level, and by 7 – 8 per cent at the 0.1 per cent. They also suggest that the majority of the costs are incurred at the processing stage, where the segregation costs are particularly high, as significant down time is needed in order to clean the production equipment.

The House of Commons Select Committee on Agriculture conducted a series of investigations which examine genetic modification and which contain useful qualitative information. One report, which is particularly relevant, focuses on the issues of segregation[88]. In the course of their inquiry, the committee interviewed witnesses and obtained written submissions from representatives from all of the involved parties. Some of the evidence contains views on the costs of segregation which we have used in our analysis where appropriate. These include submissions and interviews from MAFF; Novartis, a seed company currently developing GM crops; Cargill plc, a firm which buys and transports crops around the world; PG Economics, who participated in the Food Biotechnology Communication Initiative; Strategic Diagnostics Inc, a company involved in the testing of GM foods; Northern Foods, a UK food company; and Du Pont, a company who manage an identity preservation system for soya and maize. Although the report concludes that "segregation of GM and non-GM crops is possible without incurring excessive costs to the consumer" the views of the witnesses on this matter differed widely. Novartis, for example, felt that the need for dedicated equipment and additional cleaning costs would lead to a significant price increase, while Du Pont took the view that although some legitimate extra costs would be incurred they would not necessarily be excessive.

The House of Lords Select Committee on the European Communities have also addressed the GM issues in a report on EC Regulation of Genetic Modification in Agriculture.[89] They conclude that "to require traceability for all agricultural commodities would be an exceedingly costly exercise for little benefit".

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88 House of Commons Select Committee on Agriculture (2000).

89 House of Lords (2000).

KPMG have conducted a study which looks at the costs to the food industry of a change to the labelling legislation in Australia and New Zealand.[90] This legislation requires mandatory labelling of all GM foods whether they are chemically different from their non-GM counterparts or not, and includes processing aids and additives (although it does not include foods which include produce from animals fed on GM feed). There is no allowance for adventitious contamination and no threshold level for labelling. KPMG do not separate the costs into the different stages of the supply chain. However, they do break down the total costs of the industry into set-up costs, on-going costs and 'consequential annual costs', the last of which they define as "all costs associated with substitution of non-GM ingredients for existing ingredients in order to maximise compliance whilst protecting their existing market share". They also estimate how these costs might change with a relaxation of this legislation, highlighting the fact that the costs can be significantly reduced if the legislation is relaxed so that processing aids and ingredients which do not differ from the same ingredient made by conventional processes are excluded from the legislation. Their estimates for the costs of the proposed standard are shown in Table B.2 which includes, for comparison, their estimates for the costs of introducing legislation similar to the current EU standard (i.e. Option A) rather than the considerably more stringent proposed standard.

Table B.2
Estimated costs to the Australian and New Zealand food industries of alternative labelling regimes for GMOs (€ millions)

	Set-up Costs	On-going costs (annual)	Consequential ingredient costs (annual)
Proposed Standard	A: € 96.718	A: € 58.482	A: € 114.708
	NZ: € 19.762	NZ: € 2.277	NZ: € 16.988
Costs if used current EU standard	A: € 69.988	A: € 16.456	A: € 950.006
	NZ: € 9.154	NZ: € 1.214	NZ: € 9.255

The KPMG report also estimates the enforcement costs which, in Australia, range from €357,500 – €660,000 for the set up costs and €319,000-€7,975,000 per annum for operating costs, depending on whether a passive, risk-management or active approach is taken. In New Zealand they estimate costs of the "most likely cost structure" to be around €32,200 and on-going costs of €207,000 per annum.

KPMG also undertook a study on behalf of the University of Guelph[91] which looked at the potential costs of mandatory labelling of biotech foods in Canada. The analysis was based on the assumption that any food products derived from genetically modified plants, animals or micro-organisms would be labelled. The costs are broken down into the various stages

[90] KPMG (2000).

[91] KPMG Consulting (2000).

along the production line, although at times the estimates are based on very limited information. They suggest that as a minimum the labelling requirements could result in cost increases equivalent to 35-41 per cent of the producer price (9-10 per cent of the retail price) of the relevant products, with a total cost of €770 – €1,045 million per year. They estimate that this is equivalent to an increase in average retail prices for all food in the range 1.3 to 1.8 per cent.

There have also been a number of studies which look specifically at the costs of IP for grain elevators and handlers. Bender et al., for example, obtained estimates of the magnitude of the different costs incurred in handling speciality corn and soyabeans by surveying firms who handle speciality crops and are therefore already required to segregate.[92] They estimate a total additional cost of €0.35 per bushel (approximately €13.5 per tonne). A study by Maltsbarger and Kalaitzandonakes also looks at segregation costs at the elevator level in the US, focusing in particular on the hidden or opportunity costs that can occur from adapting current operations to identity preservation[93]. They come up with a figure of €0.18 – €0.30 per bushel (around €7 – €11.5 per tonne), although, unlike Bender et al., they do not appear to include the cost of segregated transportation.

Clarkson Grain, an American company which supplies segregated grain, has also produced a paper on the economics of IP.[94] It considers the costs and benefits of supplying identity preserved raw materials from farm to processor or feeder, including some estimates of the costs at each stage. They quote a premium of €7-€26 for supplying non-GMO materials.

Further estimates of the cost of IP were quoted in Reuters World Report[95] and USDA Outlook Forum[96] in the course of discussing the potential impacts of GM foods. The first quote was given by a representative from a food processing company who estimated that separating GMO-free crops for export to Europe would increase the costs by €86 per tonne for soyabeans and €60 per tonne for corn. The second came from an exporter who estimated that the cost would be more than the €27.5 premium he received for segregated soyabean meal.

A summary of the cost estimates provided by these studies is provided in Table 5. 3. The estimates vary considerably according to the exact situation referred to. Indeed, a common theme throughout all the studies is that the costs of identity preservation or segregation depend crucially on the tolerance level specified and the quantity of the product which is handled. Those studies which also consider manufacturers stress that the costs are also significantly increased if the labelling legislation extends to processing aids and flavourings.

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92 Bender et al (1999) .

93 Maltsbarger and Kalaitzandonakes (2000) .

94 Clarkson (1999).

95 Kaiser (1999).

96 Brookins (2000).

Table B.3
Estimates of Costs of Segregation or IP at different stages in the supply chain

Supply chain stage	Report	Estimated Costs per tonne
Farmers	EC DGVI	IP premia of €2 – 12
	Buckwell et al.	Soyabeans: €10-11
	KPMG	14% of producer price
	Clarkson	Avoiding contamination: €4 -€9 Increased production costs by using non-GMOs: €8.10
	Novartis	€6.4 – 7.6 for elementary precautions
	Strategic Diagnostics	€18 upwards
	Cargill	€6.4 – €14.9 farmgate premia
Grain Elevators and Handlers	EC DGVI	€1-9
	Buckwell et al	Soyabeans: €2-€8.10
	Uni Of Guelph	10-11% of producer price
	Bender et al	€13.5
	Maltsbarger et al	€7 -€11.5.
	Clarkson	Shipping: €5.50–€7.20 Verification: €1 -€22
	Strategic Diagnostics	
Processors / Manufacturers	EC DGVI	€1.5 –€9
	Buckwell et al	Soyabeans: €6.90-€14.0
	Uni Of Guelph	11-16% of producer price
	Northern Foods	to dedicate a UK soya mill: 18 €
Total industry costs	EC DGVI	€5 –€25
	Buckwell et al	€14 - €30
	Sainsburys / NFU	1 - 2% increase in meat prices
	KPMG (total costs)	Australia: set up costs: €96.7 mill ongoing costs: €58.48 mill / annum consequential ingredient costs: €114.7 mill / annum New Zealand: €19.76 mill ongoing costs: €2.28 mill / annum consequential ingredient costs: €16.99 mill / annum
	Uni Of Guelph	1.3 – 1.8% of all retail sales of food
	Clarkson	Non-GMO: €7-€28
	PG Economics	15%-25% of farmgate price
	Reuters World Report	€86 for soyabeans, €60 for corn
	USDA Outlook Forum	€27.5 for soyabean meal
Regulatory Body	KPMG (total costs)	Australia: set- up costs: €357,500– €660,000 operating costs of €319,000-€7,975,000 per annum New Zealand: set- up costs: €32,200, on-going costs: €207,000 per annum.

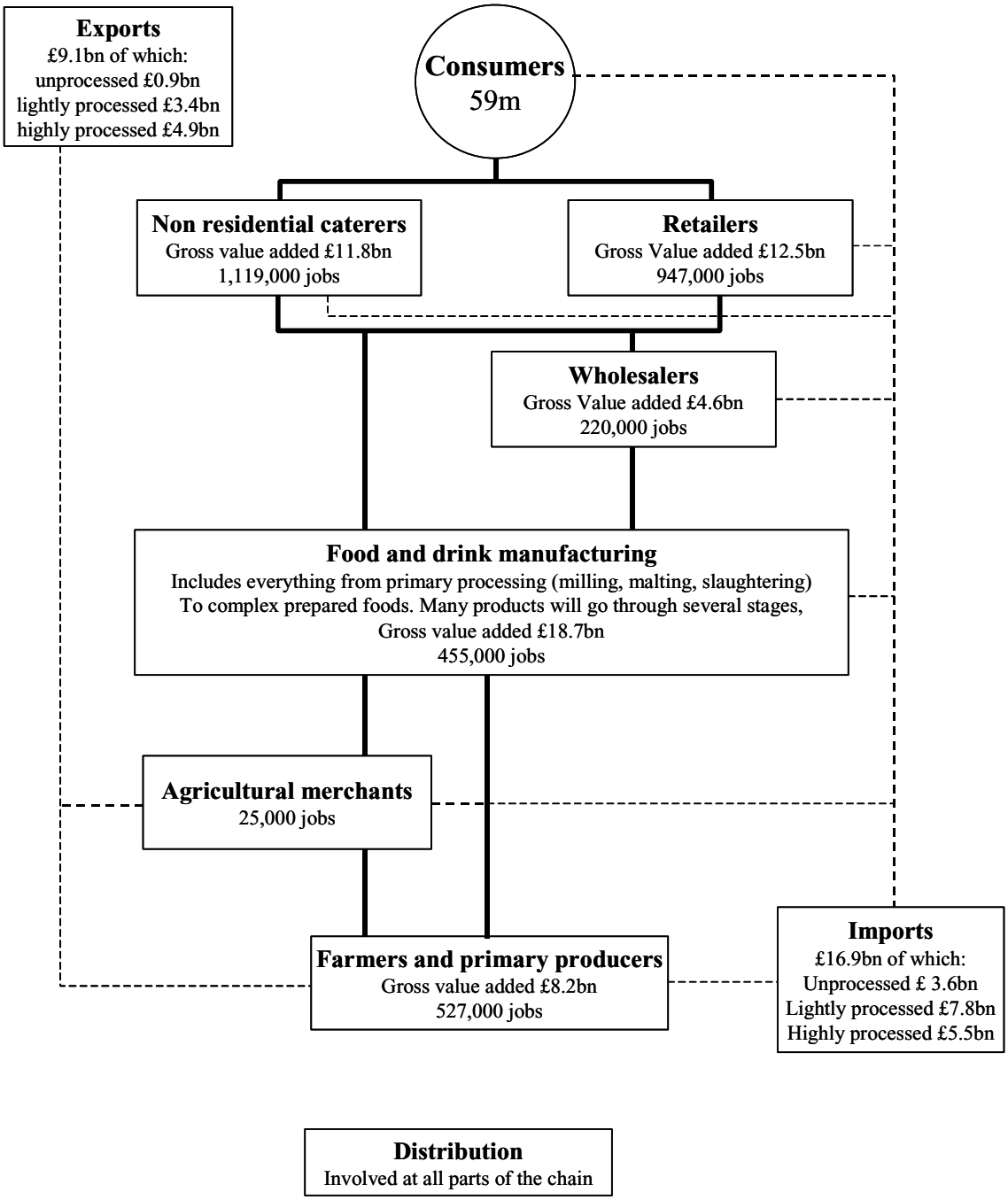
APPENDIX C. STRUCTURE OF THE INDUSTRY

The diagram overleaf, produced by the Food Chain Group, provides a useful representation of the structure of the food industry in the UK, showing the main actors and how they are linked.

Nevertheless, since one of the important parts of this study is an examination of the distributional impacts on consumers of the introduction of the four labelling options, we have found it convenient to think of industry structure in terms of the supply chains that lead to the delivery of final food products to customers. This approach leads to a need to define the food groups that will form the basis of the analysis. These major food groups have been identified on the basis of similarities in the type of food, in the level of processing, in the possible price elasticities and on the basis of data availability. Inevitably this process leads to some simplification.

Our views on appropriate food groups, which cover all categories of food and non-alcoholic drinks, are set out in the remainder of this section.

Figure C.1
The UK Food Chain



Source: Working together for the food chain: Views from the Food Chain Group (1999)

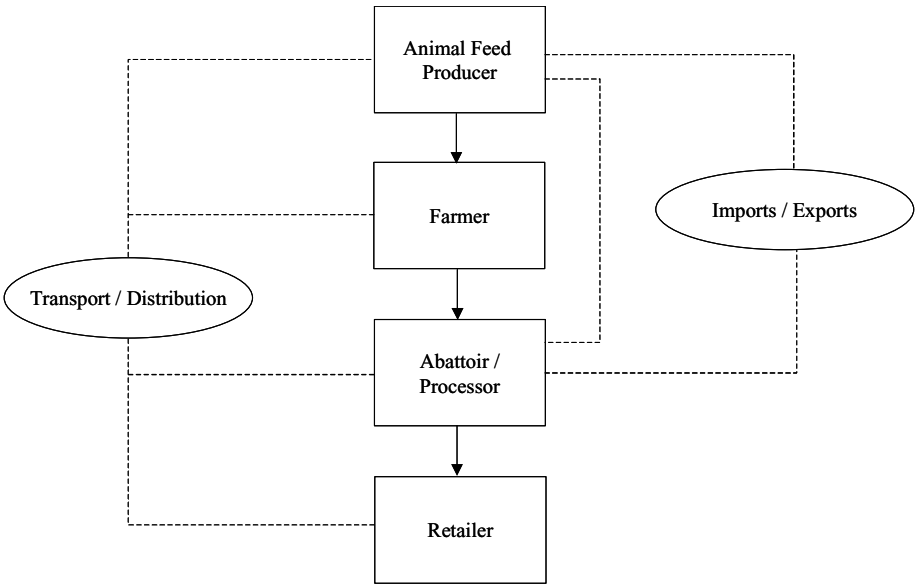
C.1. Meat, Fish and Dairy Products

We have defined this food group as being made up of the following categories from the Family Expenditure Survey:

- Beef and veal (uncooked);
- Mutton and lamb (uncooked);
- Pork (uncooked);
- Bacon and ham (uncooked);
- Poultry (uncooked);
- Cold meats, ready to eat meats;
- Meat pies, sausages and other meats;
- Fish, shellfish and fish products;
- Fresh milk;
- Milk products including cream;
- Butter;
- Cheese; and
- Eggs.

Most of the items here are lightly processed, though some elements, such as ready to eat meats, fish products and cheese can be highly processed. At present the main scope for the introduction of GM in this food group appears to be through the components of animal feed, including both processed feed purchased by farmers and the seeds used to grow grasses etc on farms. However, there is clearly also scope for genetic modification of the livestock themselves. We have developed the following simplified representation of a model supply chain for this group of foods.

Figure C.2
The Supply Chain for Meat, Fish and Dairy Products



C.2. Fruit and Vegetables

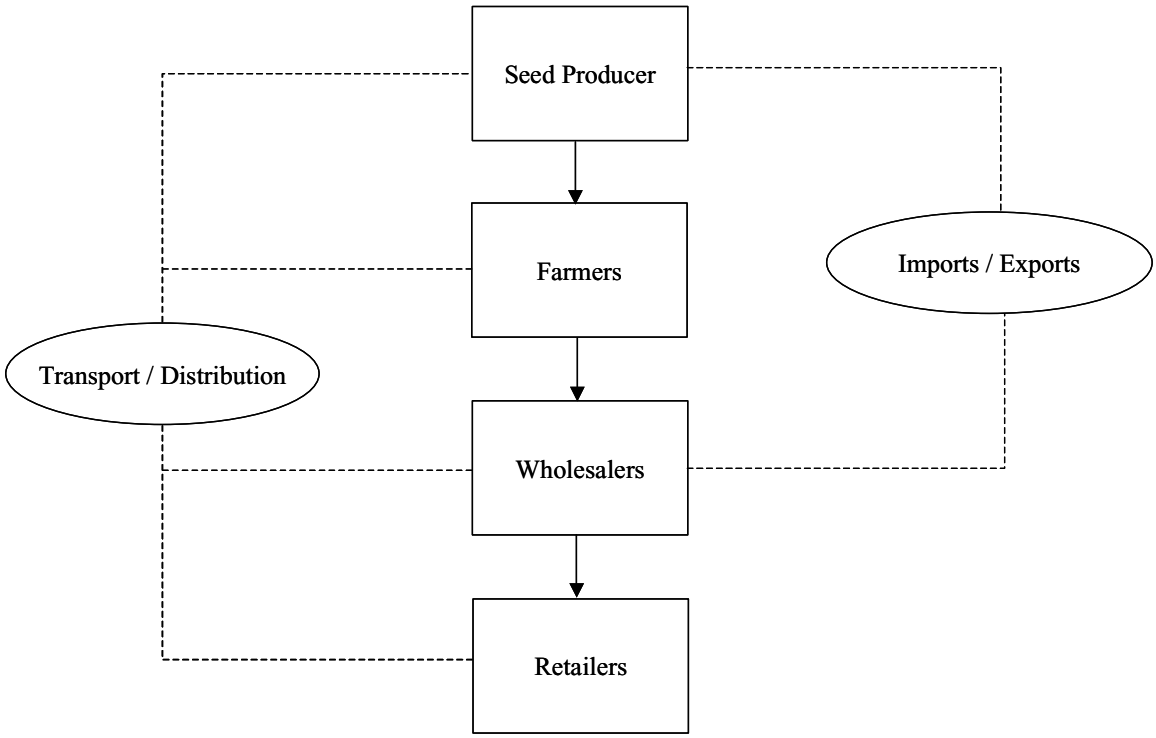
We have defined this food group as being made up of the following categories from the Family Expenditure Survey:

- Potatoes, potato products (excluding crisps);
- Other vegetables; and
- Fruit, nuts.

These food products are largely unprocessed and so the main scope for the introduction of GM is thought direct modification of the foods themselves. This food group may contain some products where additives and/or processing aids are used.

We have developed the following simplified representation of a model supply chain for this group of foods.

Figure C.3
The Supply Chain for Vegetables



C.3. Bread and Cereals

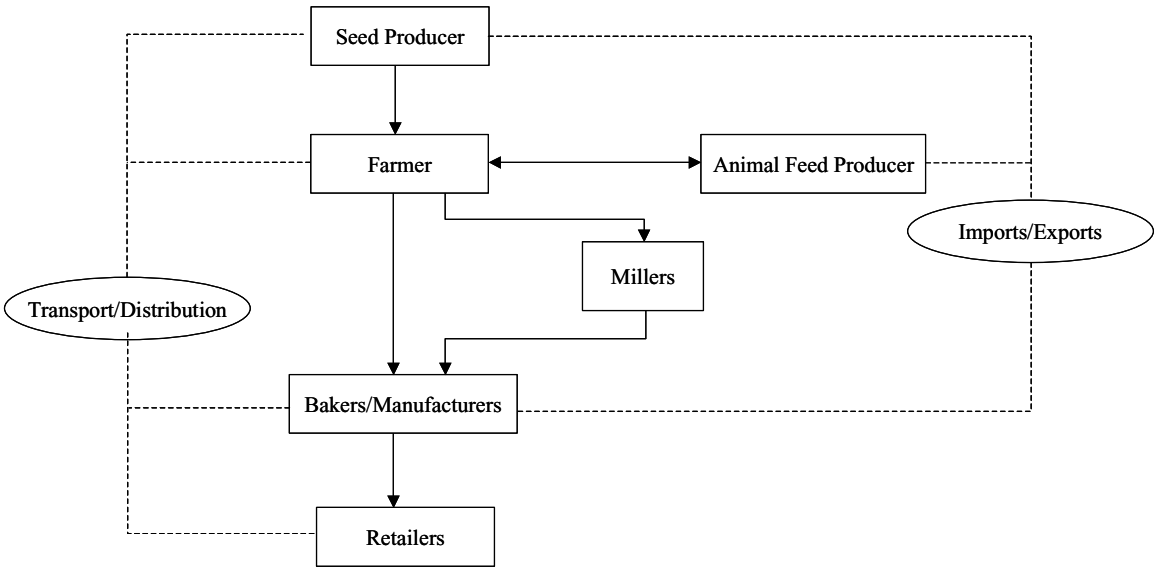
We have defined this food group as being made up of the following categories from the Family Expenditure Survey:

- Bread, rolls etc;
- Pasta, rice, flour and other cereals;
- Biscuits, cakes etc; and
- Breakfast cereals.

Most of these food products are highly processed, often with milling as the first stage in the processing. Some elements, particularly breakfast cereals, are less highly processed.

We have developed the following simplified representation of a model supply chain for this group of foods.

Figure C.4
The Supply Chain for Bread and Cereals



C.4. Other Highly Processed Foods

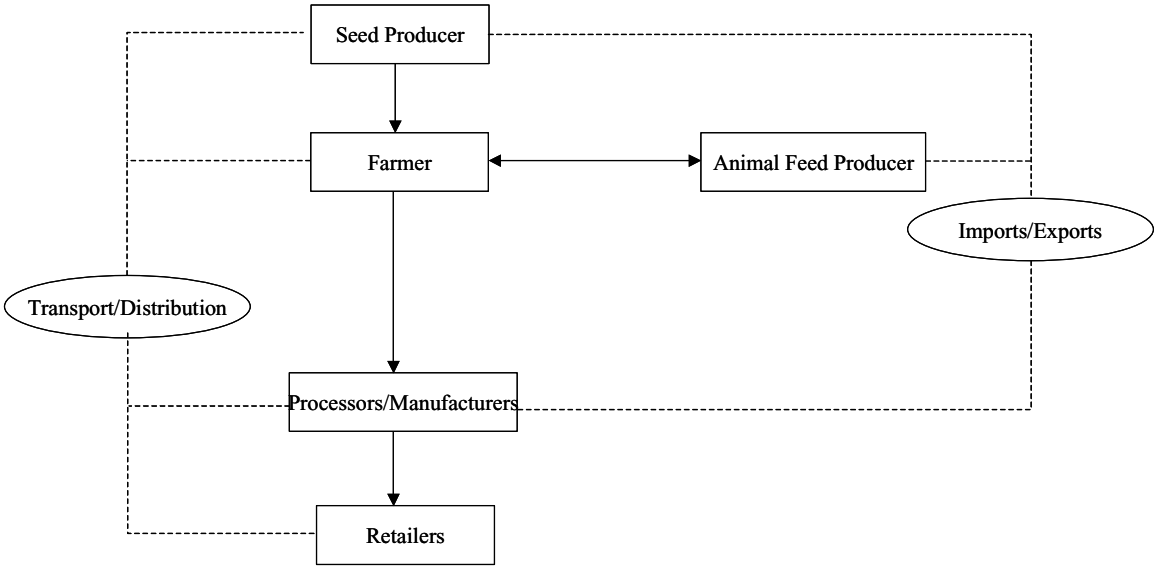
We have defined this food group as being made up of the following categories from the Family Expenditure Survey:

- Margarine;
- Cooking oils and fats;
- Sugar;
- Jam, jellies, preserves and other spreads;
- Sweets and chocolates;
- Ice cream and sorbets;
- Soup;
- Pizzas, vegetarian pies, quiches;
- Other convenience foods;
- Potato crisps and savoury snacks;
- Restaurant and café meals;
- Take away meals and snack food;
- State school meals and meals at work; and

- Other foods.

This food group contains a huge variety of highly processed foods, including takeaway and restaurant meals. Most existing varieties of GM crops contribute to this food group (eg soya, maize, rapeseed oil). The use of GM additives and processing aids will be an issue for this group. We have developed the following simplified representation of a model supply chain for this group of foods.

Figure C.5
The Supply Chain for Other Highly Processed Foods



C.5. Non-alcoholic Drinks

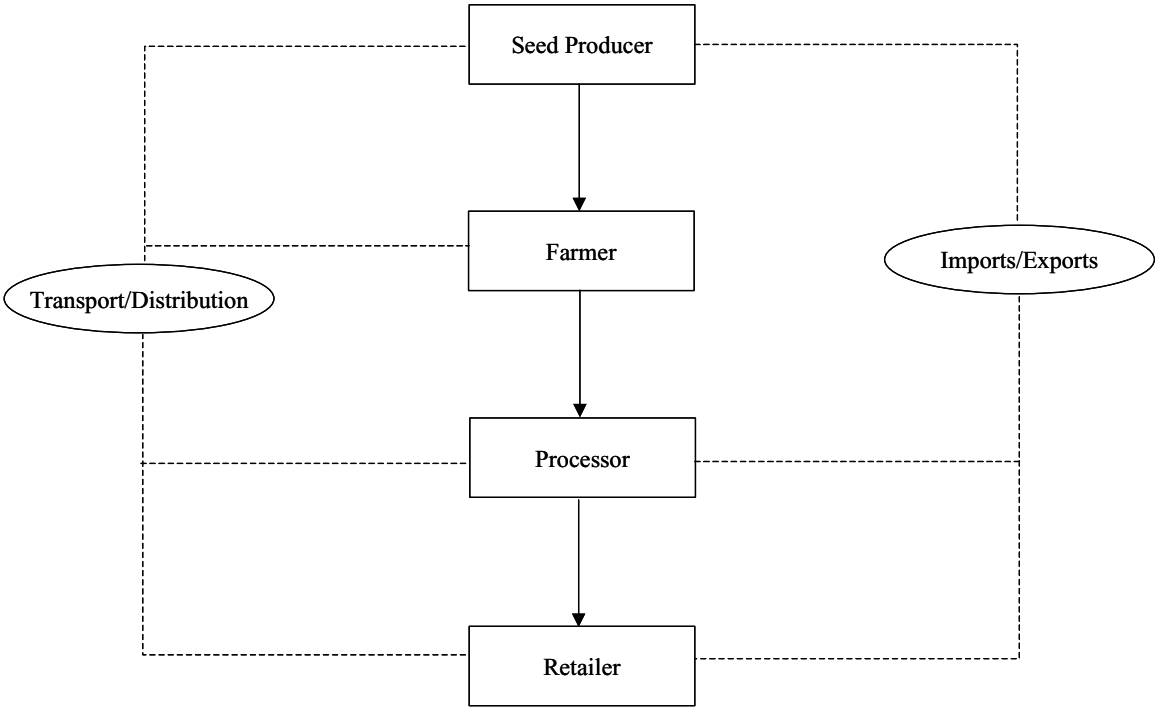
We have defined this food group as being made up of the following categories from the Family Expenditure Survey:

- Tea;
- Coffee;
- Drinking chocolate, other food drinks;
- Fruit juice, squashes, bottled water; and
- Fizzy drinks.

This food group contains mainly highly processed drinks, though fruit juice, squashes and bottled water are less highly processed. The use of GM additives and processing aids will be an issue for this food group.

We have developed the following simplified representation of a model supply chain for this group of foods.

Figure C.6
The Supply Chain for Non-Alcoholic Drinks



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