RESPONSES TO QUESTIONS FROM THE PUBLIC ON GENETIC MODIFICATION

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In July 2002, Environment Secretary, Margaret Beckett announced that there would be a public dialogue on GM issues that would have three strands: a public debate, a science review and an economics review. An important function of this process is to seek and respond to questions and concerns arising from the general public. A series of foundation workshops were conducted (by Corr Willbourn) before Christmas 2002 to identify questions from "grassroots" members of the public; in particular, from those who do not have a developed view on the future of GM crops. This paper provides brief responses to these questions, taken from a wide range of contributors, primarily from those with a scientific background.

A Basic Information and Definitions

A1 *What is GM? How is it done? Where is it done? Does it have to be done in a lab?*

Genetic modification (GM) allows chosen individual genes to be transferred from one organism into another, including genes between non-related species. Such methods can be used to create GM crop plants. The technology is also sometimes called "modern biotechnology", "gene technology", "recombinant DNA technology" or "genetic engineering".

The actual transfer of genes into the selected organism (a plant for example) always takes place in a laboratory under carefully controlled conditions. Genetically modified plants can later be trialled in a special glasshouse or in fields under regulatory oversight, before being grown commercially.

A2 *What does it mean? How wide is its definition?*

Genetic modification refers to the ability, discovered about 30 years ago, to move genes from one organism to another. Since the DNA genetic code is

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universal, genes from one organism can work in any other. In this sense the technique can be used within any living system.

- ***can everything with genes be modified / can it be done on humans?***

Yes. In theory, any organism containing genes can be modified, even humans. Nevertheless, practical and functional methods have not been developed for all types of organisms.

- ***is spraying crops with pesticides classed as genetic modification?***

No. Spraying crops with pesticides has no impact on the crop's genetic material. Pesticide application is a normal practice in conventional agriculture.

- ***is it a speeding up of a natural process like the survival of the fittest?***

Not really, although if the modified plant or micro-organism is better adapted to the environment than its unmodified precursor, it may occasionally be fitter in nature. This is the reason for strict controls on laboratory and fieldwork until there is enough information on how any new GM organism will actually behave. However, field experiments have shown that most genetically modified organisms, and indeed most domesticated crops, are not well adapted to compete in nature.

A3 ***Does it involve chemicals? Which ones and how?***

Yes, chemicals are used during the genetic modification of organisms in the laboratory. This is because all living beings are made of chemicals; they are the building blocks from which we are all made. All foods are chemicals – table salt, pizzas, the lot! Except for the introduced DNA (genes) and the proteins the genes produce, the actual chemicals used in the genetic modification are not present in the new plant variety.

A4 ***When and how did it begin? How long has it been going on?***

The particular scientific discoveries on which current gene technology is based were made in the 1970s.

In June 1973, a conference was held to discuss safety issues. The US National Institutes of Health and of Medicine were asked to appoint a committee to study the matter. Another meeting in 1975 concluded that genetic modification work should continue with appropriate safeguards in the form of physical and biological containment procedures.

It was from these beginnings that the current regulatory frameworks and procedures were developed, first in the US (where applications of the technology began) and then, along roughly similar lines, in other developed countries.

The first GM plants began to be developed in the early 1980s.

A5 ***Does it work?***

Yes, genetic modification works, and works well. The techniques have been applied successfully for human medicine, agriculture and industrial applications.

Some examples:

a) all the human insulin needed by diabetics is made by genetic modification in bacteria; it is perfectly safe and has been completely accepted by all;

b) chymosin, a substitute for rennet from the intestinal lining of calves is made by genetic modification in bacteria and is used to make "vegetarian" cheese;

c) large amounts of GM crops have been grown in North and South America including cotton, maize and soybean. In the case of soybean, more than 50% of the global soybean crop is GM.

B Current Status of GM

B1 *How much is on the market? What percentage of foods on the market are GM? What crops are already genetically modified?*

In 2002, an estimated 52.6 million hectares of GM crops were planted worldwide. This corresponds to about twice the land area of the British Isles. The area for 2002 is estimated to be 58.7 million hectares. Annually, there has been a double-digit percentage increase in the worldwide GM crop growing area since 1996.

In North America, 70% of processed foods are estimated to contain GM ingredients. For the UK the answer is less clear. Many British supermarket chains say their own house brands are free from GM components but whether this means "totally free" or "substantially free" is not obvious. Supermarket non-house brands normally do not make such a claim.

The major crops that have been genetically modified to date include soybean, maize, cotton, potato, squash, papaya and oilseed rape. Work is ongoing on many other plant types.

B2 *What new GM crops / foods are planned?*

Modifications in a wide range of crops are at the research and development stage internationally, including the following examples:

Stress tolerant crops (e.g. to drought, cold and saline soils)
Pest and disease resistance
Improved crop keeping quality
Improved oil crops for food and industrial processing
Improved feeding value
Improved Vitamin E content
Elimination of specific food allergies
Pharmaceutical production (vaccines, cystic fibrosis treatment)
Energy crops (ethanol)

Trees for papermaking

The crops being modified include: cabbage, chilli, cotton, forage grasses, forage clovers, melon, maize, papaya, peanut, petunia, potato, rapeseed, rice, soybean, squash, sweet pepper, tobacco, tomato, and wheat.

B3 ***Who produces GM food?***

Today, GM crops are grown in approximately 17 countries worldwide (Argentina, Australia, Canada, Chile, China, Czech Republic, India, Indonesia, Japan, Philippines, Poland, Romania, Russia, South Africa, Spain, Uruguay and the US). Many others, including the UK, are conducting field trials with a view to commercial cultivation. Brazil has extensive unauthorised production.

About 6 million farmers grow GM crops worldwide. Over 75% of them are small, resource-poor farmers in developing countries. Many other countries import GM food crops from producing countries.

B4 ***Who eats GM food? Do the producers eat it?***

The producers of GM crops are also consumers. In countries where marketing of GM food products is authorised, they are widely used as food and food ingredients.

B5 ***Are we being fed GM foods without knowing it? Do we get told what is GM and what isn't in supermarkets? Do you have to label GM food as GM? How can we tell if it is a GM product / if we've eaten GM?***

In addition to GM foods themselves, many foods contain GM food additives made from GM microbes. There are different attitudes in various countries about whether labelling is necessary and how to do it.

Labelling procedures are being developed in the EU and the UK. The European approach considers not what the product is (for example, oil from GM oilseed rape is chemically identical to that from a non-GM source) but how it is made. Current thinking is to apply a label "contains" if the proportion of material *of GM origin* in any ingredient exceeds 0.9%. The UK government view is that for refined foods like oil this is impracticable because it may be impossible to detect the GM content, and that legislation that cannot be enforced is futile. The British view favours a "GM-free" label for those who wish to use it.

The US attitude is to label a food for what it is, not for how it is made. There is accordingly no mandatory requirement to label a product as GM because the foods approved are as safe and nutritious as the unmodified crops from which they came. The American view is that a label flags up some sort of danger that is simply not true. However, in the USA, labels (either "contains" or "does not contain") may be used voluntarily so long as they meet normal requirements: they must be informative, accurate and truthful.

The new legislation on the EU is not yet in force. Many British supermarket chains say that their own house brands are free from GM components, but whether this means "totally free" or "substantially free" is not obvious. Non-house brands normally do not make such a claim. Organic foods claim to be entirely free from GM components

There is currently no way of telling by taste or appearance whether what you have eaten is GM, because it is just like conventional food. The difference may be detectable using very sensitive laboratory methods. Many people from the UK eat GM foods on holiday in the USA without worrying about it.

C Rationale

C1 *Why do it? Why change what we've got? Is there a need for it? What can it be used for? Who is demanding GM / who says there's a need for it? Is it principally driven by profit? Is it driven by scientists seeing what they can do by playing with nature?*

The prime reason for using gene technology in agriculture is to continue to improve the quality and yield of the products on which we all depend, without bringing ever more wilderness or recreational land into cultivation. The aim is also to minimise chemical inputs in agriculture. Previous advances in agriculture have been extremely valuable in the past, but progress in crop improvement is now slowing down. With the world population growing the way it is, together with the popular wish to reduce chemical inputs and the need for farmers to earn a fair living, we need to harness new technologies in a responsible way.

GM technology can play its part in improving yield, reducing chemical and labour inputs, aiding soil conservation, saving water resources, bringing some unusable waste land (salty, arid, high metals content) into productive use, providing nutritional benefits and offering a number of opportunities for the production of medical products at prices which poor countries can afford. It may also provide some solutions to help us to deal with the problems of climate change.

The overwhelming majority of scientists and many lay people are in favour of going ahead with the development and application of GM crops. Governments, too, recognise its value but some, especially in particular Developing Countries, are afraid that if their export products (on which they depend heavily as sources of foreign currency) use GM sources, they may not be accepted in Europe.

The scientific discoveries and advances were (and are) made mainly in universities and public research institutes as part of the fundamental progress of biological understanding.

In contrast, in Western countries, developing and bringing improved crops to market is overwhelmingly a private sector function and companies need to be profitable or they cease to exist. The livelihoods of companies large and small depend on their taking good care of their clients and customers for fear of losing them to competitors. Companies wishing to develop and market new agricultural products undertake enormous commercial risks because of the vast investment and sales uncertainties; there is no point in them treating their clients in cavalier fashion.

C2 ***What are the real benefits? Who is benefiting and who will benefit?***

We will all benefit now and in the future: from better and cheaper food and other plant products, an environment less damaged by agriculture, more wild and recreational land saved from the plough, and less poverty and food shortages in developing countries.

C3 ***Will it benefit <u>our</u> lives and how? What's in it for me?***

Direct benefits for the UK consumer in the form of products on the shelves will take time to come through, but if we say "no" to further development we will never have them, while more far-sighted people will benefit.

There are three primary areas of benefit: health, environment and the economy. For the UK in the short-term we will enjoy:

(a) farmers able to use the best of modern methods, increasing their efficiencies and incomes, contributing more and being less of a burden on the tax base;
(b) consumers being offered the best quality products from our own country and around the world;
(c) in our own UK environment, the deployment of more "environmentally-friendly" techniques without loss of productivity or the need to bring more land into agriculture, taking it away from recreational and wilderness uses;
(d) maintenance and improvements in our skills base, slowing down or preventing the loss of our scientists to more progressive countries;
(e) retention in the UK of extremely important technology-based industries based upon modern biology**;** at present industries are already finding a better research and business climate abroad.

C4 ***Will it make life easier / give us better food / more nutritious or healthier food / food with a longer shelf life? Will it be cheaper (by how much and why?) or cost more?***

All of those things, but not next week. New crops need time to be developed and properly tested; it takes time, effort, money, and cannot be rushed.

If we in the UK do not put our heads in the sand, we can expect benefits to begin to flow progressively within a few years. In the USA and Canada, the benefits are already to be had: lower use of pesticides, higher yields and better agronomic practice. Meantime, parts of the Developing World with fundamental food problems, are seeing the benefits already: crops with the potential to solve critical nutritional deficiencies, crops allowing farmers to improve their agriculture beyond mere subsistence and getting a little money in their pockets to begin to move out of poverty. Is that not worth having?

C5 ***What is the biggest advantage GM crops can bring the world?***

Adequate food supplies for a burgeoning population without excessive invasion of current non-agricultural land.

C6 ***Will it have medical benefits e.g. a cure for diseases such as cancer?***

This is a real possibility in two ways; (1) The opportunity to improve the nutritional value of food and to increase antioxidants in food; and (2) The use of specially constructed GM plants as "factories" for producing medical substances; they are cheap and easy to grow on a large scale, and so can reduce the costs of drugs. For example, if a vaccine against HIV were to be developed, there are currently no facilities for producing it on a large enough scale for the Western World, let alone Developing Countries where the need is much greater. Possibly thousands of kg would be needed each year and we simply do not have that capacity at present.

It is important to ensure that GM plants used for making medicines are segregated from food crops. There are many ways to do this: geographical (growing GM medicine plants are grown in different areas from food crops), containment (growing them only in greenhouses), or using non-food varieties (e.g. white tomatoes, blue potatoes) so that it is easy to distinguish the different kinds of plants.

Familiar foods like tomatoes containing antioxidants and other substances that may have anti-cancer properties or help prevent cardiovascular disease can be modified to provide greater and more effective quantities of the beneficial compounds without increasing the amount to be eaten.

Yet another possibility is to remove the allergens from peanuts and other foods that can provoke severe, even lethal, effects in susceptible patients. It might be possible to modify the offending gluten protein in wheat for sufferers from coeliac disease.

C7 ***Will it benefit the world's population, especially the Third World e.g. problems of food and water supply?***

A major problem in the developing world is the increasing demand for more meat. This means that there needs to be a significant increase in animal production from already stretched resources.

Food now and in the future remains a major problem. The world's population is expected to increase from the present 6 billion to between 9 and 10 billion by the middle of this century, but with changing diets crop productivity needs to double. Yet arable farm land is constantly being lost as people build more houses, roads and work places. Supplies of fresh water are already being pushed to the limit in many areas. Furthermore, around 800 million people are even now malnourished. We need every methodology we can get hold of to increase the world's food production without invading more of the remaining uncultivated land than we absolutely have to do.

Of equal importance are foods improved to provide essential dietary supplements missing from the normal foods of people in many developing countries; people are too poor to buy vitamins and other missing components. "Golden rice" to supplement Vitamin A in rice-eating communities and prevent hundreds of millions of cases of blindness, and the new protein-rich potato recently reported from India are examples of the need and urgency for these products in many parts of the world.

Vaccines are currently under development for hepatitis, cholera, diarrhoeal infections, HIV, tetanus, rabies and other diseases. These can be produced in food crops (tomatoes or bananas, familiar to the patients) and immunity is evoked by eating a small amount instead of having to receive injections. This is likely to be of enormous importance in poorer countries in which refrigeration for storing vaccines is limited and there are few skilled staff to administer the immunisations. Furthermore, people often do not come back to the clinic for the necessary boosters; giving them food wafers to eat at the appropriate time is much more likely to work. The cost of food-administered vaccines is many times less than using injections.

C8 ***What impact will GM crops have on alternative uses of crops e.g. GM oilseed rape for biofuels?***

Agriculture is a source not only of food, but also of many other valuable goods such as cotton, wool, hemp, industrial oils, starches and biomass for energy generation. As we move towards a greater use of renewable raw materials for industry and look to increasingly efficient production processes there will be a greater emphasis on non-food crops. Biotechnology has much to offer for the development of these crops.

Already the current generation of GM crops could be used for biofuel production. Herbicide tolerant sugar beet could be used for ethanol production that would have a significant positive effect on the economics of biofuel production and its competitiveness with fossil fuels. Although present varieties of oilseed crops can be used for the production of biodiesel fuel, the next generation of GM oilseed crops will see the development of varieties with considerably enhanced oil content which will further reduce the costs of biodiesel production.

Many of the plastics that we see as litter in our countryside could be made from starch rather than oil-based raw materials, as is currently the case. The starch-based plastics could then be manufactured so as to be biodegradable, making their eventual disposal as waste both simpler and cheaper and also removing what has been an eyesore in our environment for many years. Starch based plastics can be made from crops already in use, but with GM technologies the starch qualities of these crops could be modified to make additional plastics with enhanced qualities.

D Possible Risks to Health

D1 ***Is it good for me or dangerous? How will it affect us? Are there negative effects / side effects / drawbacks to balance against the benefits?***

GM crops, unlike conventionally bred crops, are tested exhaustively by looking for any hazards associated with the parent crop, the new gene, the gene product and the new plant variety. Any differences from the conventional variety from which the GM crop was bred are studied in detail and a full health and safety assessment made. In consequence, GM foods are at least as safe and nutritious as their non-GM counterparts. The majority of them are currently not specifically designed for health benefits, but in some well-defined cases the genetic modification will introduce medicinal or

nutritional benefits. In such cases, they might be targeted for specific populations suffering from nutritional deficiencies, like the GM rice and potatoes being developed in SE Asia to combat malnutrition, vitamin and iron deficiency. These are unlikely to be used in the Western World as those conditions are much less common and we have access to other medicines or technologies to overcome them.

Current GM foods in the UK will be indistinguishable from non-GM foods except by very sensitive and specific tests able to detect the actual genetic modification, rather like DNA fingerprinting.

The introduction of GM food crops is rather like the introduction of any new food variety, and new crop breeds are being produced all the time by traditional means. In conventional crop breeding we know little of what genetic changes have taken place. The new varieties of potatoes you buy from the supermarket are developed by a random mixing of genes.

All varieties, whether GM or conventionally bred, pass through DUS tests. New varieties must be *Distinctive* from other varieties on the market, plants within a variety must be *Uniform* and the variety must be genetically *Stable*.

In a GM crop the genetic modification is very precisely defined so it is possible to be forewarned about potential problems. It is not possible to say that there will be never be negative side effects or drawbacks, but GM crops are tested so extensively before being approved that the chances of anything showing up are very small indeed. The chances are likely to be much less than for conventional crops, which undergo few comparable safety tests.

There is no evidence whatsoever for GM foods being dangerous to your health. In Canada and the US, hundreds of millions of people have been eating GM foods for about seven years. Maize, soybeans and oilseed rape are commodity crops that, in North America, are not separated into GM and GM-free batches so that products made with either are likely to contain GM ingredients. Soybeans are present in about 60% of processed foods, with maize common in breakfast foods and many others. In all that time there has not been a single instance of a health effect. As one American put it, "Thirteen years of experience with biotech products in the U.S. have shown us that biotech foods developed and used in the U.S. present no safety risk beyond those of their 'natural' counterparts. Not a single ailment has been attributed to biotech foods. Not one. Not a sneeze, not a rash, not a headache."

Remember that absolute safety cannot be guaranteed for anything, including the food we eat now. Every day our newspapers tell us to be careful about how much we eat (or drink) of one sort of food or another because of medical consequences that might show up years or decades hence. Is any food absolutely safe?

The best question to ask about GM foods is whether they are as safe as the conventional foods from which they came. The answer, after years of experience, is unequivocally "yes".

D2 ***Is it harmful? Could it be harmful in the future? What harm / damage could it do to the world? Do the people who do it know if it can harm us?***

There have been endless arguments about the potential harm that GM crops could cause. In fact, all agricultural practices have an impact - farming is not a "natural" process. When you see a picturesque field of rapeseed in flower, you are actually looking at a field containing virtually no genetic diversity (all the plants are from the same seed stock) with its own specific impact on the environment. Our countryside, a patchwork of neat fields separated by hedges, was all made by people. The "natural" English countryside finally disappeared when Henry VIII had the forests cut down to build his navy.

Even organic farming which claims to be more "environmentally friendly" than conventional methods, allows practices that can be harmful, such as the use of copper based fungicide sprays and rotenone for pest control. Some GM crops, on the other hand, are developed to lessen the need for pesticides and other sprays with spectacular reductions in the use of noxious chemicals. Bearing in mind both impact on wildlife and the significant numbers of conventional farmers around the world who are poisoned every year using these chemicals, as well as their effects in the water supply, this is a major advantage for such GM plants.

Stories about harm to Monarch butterflies and other insects from GM maize turned out not to be true: an authoritative set of papers showed that the butterflies were alive and well in the US corn belt (although a quarter of them died in a freak snow storm in Mexico).

Claimed threats of “superweeds” have not materialised; the incidence of outcrossing of herbicide-tolerant GM constructs is no greater than for “non-GM” resistance varieties. There appear to be no compelling arguments for believing that GM crops are innately different from their non-GM counterparts. Their environmental impacts on invasiveness, weediness, toxicity and biodiversity fall into categories familiar from the cultivation of non-GM crops – and are much less than the environmental consequences of releasing in the UK, foreign plants bought from garden centres, as has recently been pointed out.

D3 ***Could it harm me and my family? Could it harm future generations? Will eating GM foods undermine my health?***

Over 300 million people have been eating GM food happily for up to 7 years, mainly in North America. There is no reason to believe that eating GM foods can harm you or your family.

Obviously, we already eat many foods that can be dangerous to our health. We know most of the possible food reactions, how to avoid them and importantly, how to test for them. For example, many people have potentially fatal allergic reactions to peanuts and other nuts, gut disease from gluten allergy, intolerance to dairy products, cardiovascular disorders from too much animal fat or severe illnesses from eating wild mushrooms. Lung cancer as a result of smoking also has its origin in a plant product, yet some countries

were worried about using GM-tobacco with less harmful substances than normal because some people would be scared!

D4 ***Could harm be caused by:***

- ***the chemicals used***

The process of making the GM plant, including the chemicals used, does not pass onto the plant, nor any seed derived from that plant. The only thing that is permanent is the DNA change itself. People naturally eat vast amounts of DNA from all classes of organisms in their food each year. We even digest human DNA because it is released from the dead cells in our digestive system.

- ***cross-contamination***

Foods from genetically modified plants are processed in exactly the same way as foods from non-genetically modified sources. Since the food industry has very sophisticated processes in place to test quality continuously, any contamination would immediately be detected and the problem remedied.

- ***additives***

No additives are involved.

- ***mutations***

Hundreds of crop varieties have been modified in conventional breeding using mutation induced by chemicals or radiation and we frequently buy foods derived from them. Also, all living creatures are naturally subject to random and spontaneous mutation. The process of genetic modification can sometimes cause mutations, but these are tested for and, if necessary, the affected plants are eliminated during the testing phase, which takes several years before any new crop variety is approved.

- ***altering the basic structure of things?***

A GM plant has been altered usually by introducing one or two 'foreign' genes into an organism that already contains between 30-50,000 genes of its own. We eat such foreign genes every day of our lives when we eat our daily meals. There is no change in the plant's basic structure and it looks and behaves in every way like the one from which it came, except for the intended new quality.

D5 ***Could harm take the form of allergic reactions, new diseases or a general negative effect on health?***

These questions could (and should) equally well be asked of any new food, be it a GM food, a new conventional variety of potato or a new brand of processed snack. But, in fact, usually only in the case of the GM food, will any tests for allergic reactions, toxicity or general negative effects on health, be carried out before it is released onto the market.

For example, if manufacturers want to develop a new conventional (non-GM) potato, they could simply take a wild variety of potato and cross-breed it with any other variety of potato. Potatoes, particularly wild varieties, are extremely poisonous because they contain compounds called glycoalkaloids. The manufacturer must test the new variety of potato for glycoalkaloid content to make sure it is not poisonous, but that is the only test that is required before the new potato can go to market. In the past, some conventionally bred potato varieties have had to be withdrawn because the glycoalkaloid concentrations were too high. There is no requirement to test for any allergic potential even though potatoes also contain patatin, to which allergies have been reported, or indeed any other health issues.

The question is really: should new GM crops be tested like other new food varieties, or should new food varieties be tested as thoroughly as GM foods?

D6 ***Will they be able to cope with problems / treat any new diseases that arise?***

This question is one that should equally well be asked of conventional agriculture as well as of organic products and is impossible to answer in any context about the future.

There is no reason at all for believing that GM crops will be any more dangerous that other crops, especially as the nature of the genetic change can be defined with a precision impossible for crops from conventional breeding.

It is also important to remember that GM plants are being developed for many other applications apart from food. One of these is for medicines and vaccines. New GM plants are being developed right now to enable production of enough vaccines for use throughout the world; plants also offer a unique opportunity to make medicines that cannot be made by any other means and to do so cheaply. The first example of this was a vaccine against hepatitis which is currently under trial. There are other examples in the pipeline, such as for treatment of cancer, AIDS and tooth decay.

E Other Possible Effects

E1 ***Could jobs be lost?***

No jobs should be lost in agriculture following the introduction of herbicide tolerant crops to the UK. Instead, as further crops are developed with qualities such as improved nutritional properties or oilseeds used for specific industrial purposes, more jobs could well be created, both on the farm and within the rural economy.

All advances in method and technology result in some change of job pattern; once blacksmiths were common, now they have been replaced by many more car mechanics. Every industrial advance has been feared and vehemently resisted as causing job losses yet the number of jobs has steadily increased so that today the UK has more people in work than ever before. Some sorts of jobs (perhaps in the chemical industry, making pesticides and perhaps fertilisers) may be lost but others will be created, just as throughout history.

E2 ***What will happen to ordinary farmers?***

Ordinary farmers will be able to use genetically modified seed or conventional seed as they wish. For those who choose to use the GM seed, they will be able to control weeds and pests using far fewer chemicals. This will benefit the countryside and help the farmer by lowering the overall cost of the chemicals needed to control weeds and pests in the crop.

E3 ***How will farming in the UK progress and compete?***

With the ability to use GM seed, UK farming will be able to make use of the latest technology already available to farmers in other parts of the world. Because their costs will be reduced, the UK farmers will then be able to market their products competitively on world markets without their present dependence on subsidy. This will mean a profitable, sustainable UK agriculture, which benefits both the farmer and the economy. British farmers want the chance to compete with the rest of the world on a level playing field; they don't want to be prisoners of subsidies and public charity.

All industries, including farming, have to take advantage of new developments when they occur; other countries' farmers are already doing so on a large and increasing scale, and we are being left behind. If UK agriculture is denied access to proven beneficial technologies it will become uncompetitive and unsustainable; we will all suffer the consequences of living in a poorer country, paying higher prices for our foods and having to import more of it from abroad.

We should not forget that the first GM food to be marketed in the UK was a tomato puree. The majority of consumers believed it tasted better than its non-GM counterpart and it was sold at a lower price, clearly a benefit to the weekly shopping bill.

E4 ***What could be the effects of the commercialisation of GM crops in the UK?***

- ***on UK science?***

For centuries, the Britain has been at the forefront of technological development and our economy depends on it. Biotechnology is among the most rapidly advancing branches of applied science and is seen as one of the main economic drivers of the 21st century. If the UK turns its back on commercial planting, there will be less incentive to conduct fundamental research, no need for development and the private sector will give up on Britain. This will sour the atmosphere for biotechnology in the UK as a whole, with the risk that other industries on which the UK depends heavily for export earnings will decide that this country is not the place for them. Worryingly, there are already signs of this happening.

- ***will it increase our dependence on industrialised farming methods?***

The use of biotechnological methods in agriculture has the potential to moderate and restrain the drive towards intensity in farming but it is illusory to suppose we can go back to mythical golden age of farming before there were machines and chemicals. It was a time when working farmers were often very poor.

Modern farming methods are essential for maintaining an economic yield on the limited land resources we have available. Other styles of farming which use a great deal more land area and labour to obtain their products have to charge much higher prices for products which many people see as having no additional benefit.

- ***will it increase our dependence on lower diversity and chemical dependent farming?***

No agriculture is free from chemical inputs. All life is based on "chemicals" and it is idle to suppose that crops can be grown without them.

However, by using GM crops, the dependence on pesticide chemicals will fall progressively and those chemicals which are used, are less toxic generally and less persistent in the soil. In time it might also be possible to lower the demand for nitrogen fertiliser either as ammonium nitrate or animal manure, but that is still some way off.

E5 ***Could corporations end up controlling the food chain?***

No corporation has more power than any Government. European and British laws prevent the development of monopolies and cartels. The EU Competition Directive came into force at the end of last year and there are stringent controls and severe penalties in order to prevent such control occurring. Similar laws are in force in all major industrial countries.

The control of monopoly is a function of government, not of technology. How we use our scientific understanding to best advantage is a matter of public policy, in which we all have a say.

It is a fact of life that very expensive activities - like developing new crop plants, building cars or aeroplanes, or running supermarkets - can often be undertaken only by large companies. It is society generally that has to ensure such activities are properly conducted while recognising that without profits there are no companies, and without companies no products and no jobs.

E6 ***Could world climate change be affected? What does the future hold re food, energy, environment etc?***

GM has an important role in finding solutions to adapting crops to changing climate. Crops that have reduced energy inputs and produce sustainable raw materials for food and industry are better for the environment.

E7 ***What effect might GM have on the environment? Is it destroying nature as we know it? What will the effect be on natural (non-GM?) crops / wildlife?***

Farming by its very nature is a human "artificial" activity; only when people are involved do crops grow in rows in fields and only because of human activity do our crop plants exist at all; none of them occurs in the wild in the form we use them.

GM technology is benign in the agricultural context. With a need to feed more than 6 billion people now and many more in the future, we have to grow crops in

more or less intensive fashion whatever we do. That clearly has had, and continues to have, an enormous impact on the "natural" environment and the wildlife that lives there. We as a society need to reconcile the two: growing the crops we need, while allowing as much wildlife as possible to flourish, and leaving adequate areas of land for recreation or as wilderness areas.

By reducing chemical usage and increasing yields, agricultural biotechnology makes fewer demands on the land and causes less harm to wildlife. Experience over several years in those countries which have been growing large quantities of GM crops have shown the problems to be minor and capable of being dealt with by sensible management practices.

The effects on non-GM crops is likely to be trivial. Those crops are, of course, the products of domestication and what is now considered as conventional crop improvement. They are in many cases as "natural" or "unnatural" as GM varieties. But the biosphere is a global interactive whole and we need to manage biotechnology just as we do for all other agricultural activities.

As with all crops, however they are bred, it is likely that if they are left untended, they will die out. Crop plants are selected to perform in agriculture and need the tender loving care of the farmer; without it they usually cannot compete with wild plants.

E8 ***What about pesticide harm?***

The pesticides used with the present generation of GM crops are less damaging to the environment, and less persistent in the soil, than many of the ones widely employed elsewhere in modern agriculture.

F Regulation and Monitoring of Safety

F1 ***Is it safe and how do I know that it is safe? What proof is there that it is safe? What tests are in place? Are all foods fully tested?***

Government has a responsibility to ensure that food on sale is safe and that claims can be substantiated. To do this, ministers seek the advice of a network of advisory committees, of which the Advisory Committee on Novel Foods and processes is one. Novel foods include all foods novel to the UK consumer and so include GM foods, because they are novel, not just because they are GM. The Committee is made up of experts from universities and research institutes and, importantly, contains a consumer as a full member and also an ethical adviser. It is chaired by a senior academic.

The regulatory bodies work in the public interest. Their decisions are made public as is most of the information at their disposal. They have to be satisfied that the food proposed is safe. They can ask the applicant for more information and withhold their approval until they get it and are entirely convinced that approval should be given. No such approval for a GM food intended for human consumption has ever been revoked.

Comparable safety assessments have never been carried out for most of the foods we eat. Indeed, we know that many of those are potentially dangerous. We think we know from experience that high-cholesterol foods are harmful in the

long-term because of the damage they do - or may do - to our cardiovascular systems. We also know that many foods cause allergic reactions in some people, some of them serious enough to be lethal. If such foods were now about to be offered for sale for the first time and had to pass the current regulatory procedures for novel foods, would peanuts, eggs, milk products, wheat products, strawberries and other fruits, as well as fish and shellfish, be permitted? GM foods have to pass through a rigorous safety assessment by Government agencies before they are approved.

Because safety is a negative concept (the absence of harm, damage or danger), it can never formally be proved. But we can learn from experience that something has indeed not been the source of harm, damage or danger and that it therefore appears to be safe. Although tomorrow might bring something new, the more experience we have, the more confident we can be.

Although it is hard to obtain precise figures, our food is probably safer than ever before. To take one example, in the 1930s about two thousand people a year in Britain died from drinking milk and contracting bovine tuberculosis. Now no-one dies of this cause in Britain because of pasteurisation and tuberculin testing of milk.

F2 ***What research has been carried out into the effects on health of modified foods that are already available? What research is being carried out into the potential long term effects?***

Novel foods, whether derived by GM, or newly imported from another country or produced by a novel industrial process from a novel source like Quorn, cannot be evaluated like drugs. A drug can be tested for its toxicity, first in animals and then in humans, by using very large doses, say 100 or 1,000 times higher than that expected in practice.

This simply cannot be done with novel foods as such, because it would be impossible to feed someone 10 times the normal amount of a novel fat. Not only would they balk at the idea but such a large amount would probably greatly disturb their livers, not because the food was intrinsically unsuitable. So other methods have to be used. Specifically, the gene product itself can be tested for toxicity at much higher concentrations – say 1000x – and this was done for the gene product that makes GM soybean resistant to the herbicide “Roundup”. No toxicity was detected.

Animal testing is extensively employed. Usually it is possible to use doses only a few times higher than in the normal diet. The most useful method, however, is to compare the new food with one that had been eaten for many years since the reactions of a wide variety of different peoples will be known. This is called ‘substantial equivalence’. If all these tests indicate no problem, limited human trials are possible with volunteers. This was the process followed both with Quorn (made from a mould) and when flour from lupins became available for sale. In the lupin case, allergy was the worry. Although there were no contraindications, when the flour was released into a limited area, all the local allergy clinics and GPs were alerted. In the event there were no problems.

It is difficult to do long-term trials in humans lasting many years. Over a protracted period, a thousand or more people (a large number because we are

looking for small effects), representative of the populations as a whole, would have to be fed their normal diet plus the novel food, while another equally large population would have to eat exactly the same diet without the novel food. This is just not possible. It was suggested that any adverse effect of a GM food could be picked up by monitoring a random population for illness and seeking to correlate any illness with their diet using the supermarket loyalty cards to assess the diet. This was ruled out as an invasion of privacy.

F3 ***What are the real experiences of US farmers and consumers?***

In the US, the proportion of GM soybean has increased steadily from zero in 1995 to 75% in 2002; that of cotton to 71%. GM maize (protected against attack from an insect, the European corn borer) has risen to a plateau of about 25% for three reasons: (a) not all areas of maize cultivation suffer from high levels of insect pressure; (b) the early use of insect-resistant maize had such a marked effect on reducing the insect populations that many farmers did not see the need to buy the more expensive insect-resistant seed unless the insects came back, which so far they have not done; (c) there has been concern about the sales of GM maize in Europe, a major market for US corn.

GM products do not have to be labelled in the US because their regulatory process considers that they are no different from the foods from which they originated. US and Canadian consumers have been eating them in increasing amounts for seven years. Most people in the USA and Canada seem indifferent, uninterested and unconcerned.

Environmental benefits have taken the form mainly of massive reductions in insecticide usage, especially for controlling bollworm infestation in cotton.

Estimates in 2001 in the US for the distribution of monetary benefits derived from GM-soybean show $32 million to the seed companies, $42 million to consumers, $74 million to patent holders, $796 million to farmers and $117 million to others (presumably distributors, processors, retailers, etc.). GM-soybean was developed for its agronomic benefits, not primarily as a consumer product.

F4 ***Who funds and carries out the research? How much corporate funding is there? Is the research independent? Should it be?***

Most basic research is paid for directly by governments. This work is carried out in universities and research institutes funded by grants awarded to researchers who have made a specific proposal which has been assessed for originality and quality by independent reviewers. Applied research - that is the production of a saleable product - is mainly carried out in companies who are in business to do just that.

F5 ***What controls and regulations / legislation are in place?***

All GM work carried out in Europe is governed by EU legislation which regulates research, development and the production of all such products. This includes any release of a GM organism into the environment and the labelling of any products for sale.

F6 ***Who is the regulator and are they independent? Do we need one?***

The UK has an interlocking network of expert advisory committees made up of scientists, mainly from universities and research institutes. Committees usually include a consumer representative. Recently, a second layer of three Commissions has been set up over this network to ensure that wider social and ethical issues are taken into account before final decisions are taken by Ministers. All members are independent; they are not salaried but paid only travelling expenses and a small daily allowance to cover preparation for the meetings. Any real or potential conflict of interest by advisory committee members has to be declared before any discussion takes place and they then leave the room.

G Boundaries

G1 *Will there be boundaries around what can be changed? How far will they go?*

Every application for the approval of the safety and acceptability of a novel food must be submitted to a committee on which sits an ethical advisor. He/she can advise that, whatever the scientific issues, there may be ethical issues that make wider consultation necessary. This happened, for example, some years ago when the Novel Foods Committee was asked about the safety of eating sheep into which human genes had been injected at the fertilised egg stage. The Committee decided that there were no safety issues but that many people might have ethical objections and so public consultation followed. The outcome was that the application was dropped and no such sheep were ever offered for sale.

G2 *Where will it stop? e.g. Will we get lettuces the size of houses? Will it lead to the cloning of all animals?*

There are many points at which such checks can be exerted. Everybody accepts that, even where there may be no theoretical boundaries, not everything that can be done actually should be done. In the past, there have been many occasions when scientists themselves have objected to certain developments. We live in an open society in which the media and the public have strong voices. We all have to contribute to decisions on major issues.

G3 *What are the long-term aims of all this research into GM?*

To continue to use our new knowledge carefully and thoughtfully for the benefit of mankind and the environment.

H Trust and Confidence

H1 *Why is there so much disagreement about the benefits and risks of GM?*

There are various points of view.

People generally favourable to the introduction of GM technology see it as a mainstream development from existing plant breeding. They see many benefits and few risks. They put much of the concern down to a recent history of food scares (BSE) and agricultural disasters (foot-and-mouth disease). There is also a widespread lack of understanding of modern biology and the technology that derives from it. These factors were exploited by newspapers

running scare stories in an attempt to increase their circulations and by various individuals and organisations pursuing agendas of power, increasing their membership and income, riding a protest movement and furthering their commercial or other financial interests.

Some people are generally worried about risks to human and animal health, damage to the environment and the involvement of large multinational corporations. They see agricultural biotechnology as a fundamentally new departure from existing practice with many risks and uncertain benefits. Moreover, they fear that not enough is known (and may never be known) about genetic interactions and their consequences, and think they may be other, better ways of meeting agricultural needs. Some of them also see the whole development as being driven by commercial greed with inadequate regard for safety and the public interest, with governments acquiescing because of perceived national economic considerations.

H2 ***Is everything we hear about GM from the people developing the technology?***

No. Every conceivable point of view is expressed - in the media, on the internet and in person.

H3 ***Can we get unbiased and impartial information and from whom?***

Some people do give a balanced picture of the pros and cons but they are unlikely to be neutral. When people understand an issue well, they usually take one point of view or another. The whole area is a complicated one technically and more often than not opponents of the technology exploit this by the use of simplistic soundbites like 'Frankenfoods' and 'Superweeds'. In our view, a more detailed examination will show such concerns as massively remote, but the issue is whether we trust experts or are helped to understand such allegations in sufficient detail to satisfy ourselves.

It is up to individuals to decide for themselves whether a particular source is reasonable and balanced, and hence perhaps trustworthy; there is no foolproof way of deciding. There are commercial and other financial interests behind some of opponents as well some of the proponents, but that does not make either camp necessarily dishonest. Other proponents and opponents may have non-financial interests just as powerful as money.

- ***whom can you believe or trust?***

People who talk sense, who listen and respond sensibly to criticism and who do not keep on saying the same thing for years in spite of new information; in other words, people who are not obviously banging some sort of drum.

Read the newspapers, but also read between the lines!

- ***can scientists be neutral?***

That's the same as asking whether and where one can get unbiased information. Some people give a balanced picture of the pros and cons

but if they know much about a subject they will probably have given some thought to where they stand on it.

- what is the involvement and attitude of farmers, producers, environmentalists, supermarkets, Government?

a) a poll last year showed that about 70% of UK farmers would like to make up their own minds about whether or not to plant GM crops, not have someone else make up their minds for them.

b) food processors, manufacturers and retailers usually claim to be neutral: "If people will buy, we will sell". How they decide is not clear.

c) environmentalists fall into several categories depending on their motivations. Some are very anti-GM, some mildly so, some mildly-pro and yet others very pro.

d) supermarkets are like the rest of the trade: they will sell what they think their customers will buy

e) The Government is ultimately responsible for regulatory procedures and practices as well as for deciding whether or not commercial cultivation of GM crops should take place in the UK. Many factors are involved in Government decision making. In spite of attempts to discredit the Government for its handling of crises like BSE, its regulatory machinery for new drugs, crops and crop chemicals are amongst the best in the world. BSE was not a regulatory issue, but it has been used to undermine trust in the Government's regulatory machinery.

Novel foods enter the UK diet through supermarkets which are highly regulated, through health food shops, and in open markets which are least regulated. The regulatory process is governed by the Food Act, by a series of EU regulations and also depends on advice from independents, food inspectors and many other local authority checks. So there is an extensive network to protect the public, and the GM foods that were approved for sale in the UK went though all these with particular care.

The same is true of GM crops, which have a strict regulatory regime. So Government took all reasonable steps to protect the British public but we live in a free world, where people have a right to choose for themselves, so there was no reason to restrict. Indeed many argue that Government is already too intrusive into our lives.

The UK Government is responsible for the future well-being of the UK public, for maintaining employment and for assuring that new technology can be used properly for the benefit of the UK population, and that means encouraging safe new technologies. Since there was never any reason to treat GM foods and crops as either evil or unsafe or dangerous in themselves, the proper normal procedures were followed. Government must remain neutral and protect; that is what they have done.

H4 ***Why does the Government think that the commercialisation of GM crops should go ahead (in concrete terms)?***

Government is open minded on the topic. There are compelling reasons why Government should think seriously about commercialisation because research and innovation is particularly vital for the UK, a country poor in natural resources but rich in skills. It is essential for the national well-being not only to retain a place in the forefront of scientific advance, but that those advances, whether in agricultural biotechnology or in any other field, are put to commercial use for the benefit of the UK as a whole. In the past, Britain has been one of the technological leaders of the world. It would be very ill-advised to abandon any significant progress in technology as a consequence of exaggerated and unfounded fears.

- why did it feel it necessary to decide on sites for FSEs without local consultation?

There is a legal requirement to inform local communities of the FSE trial sites rather than engage in local consultation. There was increasing local consultation over the later FSE trials sites.

H5 ***Will we be given the full picture? Do we know what happens behind the scenes?***

Very little information is concealed either by Government or the commercial sector but while much has to be searched for, almost everything of importance is on the internet. The whole of agricultural biotechnology is clearly complex and it takes a lot of effort to get a good grasp to be able to come to an informed opinion, rather than be influenced by headlines and soundbites.

H6 **If problems arise, will we get honest answers from Government? Will Government present research findings properly and fairly?**

The process has to be trusted or it is of little value. That is the reason why many different groups are represented on the Committees, why many meetings are being held in public and why there is a web-based consultation. This discussion is more open than any previous Government process.

H7 ***Who will be liable for contamination from the commercialisation of GM crops (or any other form of damage)?***

Before it can be released into the environment, any GM organism (plant, microbe or animal) has to pass through a tough regulatory process.

ACRE (the Advisory Committee on Releases to the Environment) is an independent body that advises Government on this process. ACRE will approve a release only if it is satisfied that no damage will occur. Many believe that GM crops do not raise new legal liability principles that are not already covered in conventional agriculture.

J Moral / Ethical Issues

J1 *Is it right for man to be tampering with nature? Are we playing God?*

This issue has been carefully considered by independent ethical bodies like The Nuffield Council, The Church of Scotland Society Religion and Technology project, The Church of England Commissioners and the Pope. None has found any reason to consider GM technology as unacceptable in principle. All technologies if handled properly benefit Mankind. It could be forcefully argued that it is unethical not to explore the potential of beneficial technologies.

Jewish and Muslim authorities have taken a similar view.

J2 *What legacy are we leaving future generations?*

A wealthier and more sustainable future, hope of solving existing malnutrition and poverty around the globe and a way of coping with the projected major increase of the world's population without mass starvation or the destruction of much of the remaining wilderness areas.

J3 *The involvement of the Third World: Is Africa being used as a dumping ground?*

Some African countries are in desperate need of better agricultural methods, not just food handouts. Yet the reported anti-GM attitudes of many Europeans and their governments, the powerful and sometimes antiquated farming lobbies demanding subsidies and the enormous commercial importance of the European food import market, has made some developing countries fearful of being excluded if they grow GM crops. So much for Africa being a dumping ground; most GM foods are consumed in the countries that produce them. It is expected that GM crops will contribute to helping communities to grow food locally.

- ***if the Third World needs GM, then why use it in the West?***

GM technology is valuable for both developing countries and the West Western countries gain via increased income for their farmers, lower prices and nutritional improvements for the consumers, less agricultural stress on the environment and more economic activity for the community. Governments like those in India, China and elsewhere grow GM crops developed in the West and encourage their scientists to develop GM varieties for their own special needs. As a result, a substantial amount of GM cotton in China is now developed there. It is a win-win situation for everybody.

- ***will it really help the poor or is it about making the rich richer?***

If managed properly, it has the potential to make everyone richer, except those who reject it.

J4 *Need to confront more basic problems: Why don't we acknowledge that we waste too much food rather than search for perfect food?*

There is a challenge to politicians to redistribute food more equitably around the world. The problem of wastage is not so much that we Western consumers waste so much as that some 40% of all food crops planted never reach the table. Crops are destroyed or damaged in the field by insects, weeds, fungi, worms and other agencies; food spoils in storage - eaten and fouled by rats and insects. This is particularly so in poor countries without adequate refrigeration. High spoilage is compounded by poor transport so that food often cannot get to market in good condition.

- will GM distract us from looking at proven solutions to current farming problems?

The state of British agriculture has been examined by the Curry Commission who proposed a series of recommendations for improvements. The Government has agreed to implement and fund the move towards "sustainable agriculture". GM technology will offer distinct positive advantages. It will not distract from developing proven solutions unless its opponents spend all their energy attacking it for spurious reasons and overlook the real problems.

J5 ***How democratic is it to patent genes?***

The patent system was introduced to enable people to share information while providing reward for investment in research. Patents last about 20 years, which is a short time in a plant breeding timetable. After the patent ends, everyone has access to the intellectual property.

Prior to the demise of the Soviet Union only the Western democracies respected intellectual property rights (IPR) including patents. IPR and democratic institutions seem to be valuable partners. IPR in all its forms (patents, copyrights, design, plant breeders rights) has been the foundation of our successful enterprise culture. The countries that comprised the former Soviet Union now recognise and respect IPR in an attempt to catch-up with Western democracies.

J6 ***Do I in Britain have the choice to buy GM or non-GM as I prefer?***

Not at present in the UK. Although eight GM foods have been approved for human consumption in the EU and UK (one sort each of tomatoes and soya, three each of maize and oilseed rape), most or all of the supermarkets claim to have withdrawn all foods containing such ingredients from their shelves (whether they have actually done so is another matter). Organic foods claim to be entirely free from GM components (whether they actually are is a further uncertainty since they are rarely tested). Organic foods can be freely purchased, GM foods cannot. Yet in repeated UK polls, about half of those responding say they would be prepared to try GM foods, half would not.

Consumer choice should be symmetric, something the consumer organisations never mention. By comparison, the sale of halal and kosher meat does not prevent that of non-ritually slaughtered products. The presence of vegetarian and even vegan products on the shelves does not exclude meat from a supermarket.

J7 *Do UK farmers have the choice of using GM crops as they see fit?*

About 70% of UK farmers say they would like to make the choice themselves. At present they can only choose not to grow them. Many people feel that choice should be exactly equal: use them if you want to, don't use them if you don't, not that one side should be entirely excluded in favour of the other.

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