Genetically Modified Food

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Genetically modified food is highly controversial, as has been shown by recent examples of genetically modified soya beans and maize. Supporters see it as a way of using scientific advances to develop new foods that could be cheaper than existing one, while offering the possibility of reduced pesticide use. Opponents see genetically modified food as potentially harmful. If it is not banned, they would at least like it labelled so that consumers can avoid it if they choose.

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A. What scientists can do

Genetically modified (GM) food is a product of the biotechnology industry which has developed after the discovery of the structure of DNA in 1953 by Crick and Watson. Although it took some decades for the possibilities to develop into commercial techniques, since the 1970s many new applications have appeared.[1]

Food has been the product of science for millennia. Processes such as winemaking, brewing or the preserving of foods have involved chemical changes and could be considered food technology. Selective breeding of animals has been undertaken for centuries - particularly for horses and hunting dogs - and systematic selective breeding of farm animals to develop better stock has been operating in the UK for about two hundred years. Modern food, of course, is partly the result of the application of modern science. Crops are grown with the help of fertilisers and pesticides. Additives are used to help preserve the food and to control its taste. Otherwise it would simply not be possible to obtain such a wide range of foods, of uniformly good quality, on the supermarket shelves.

The techniques of biotechnology go well beyond that. It is becoming increasingly possible to identify, within an organism, exactly which gene confers each particular quality and to either alter that gene, or even transfer that gene to an organism of a different type. Of course, the complexity of life is such that a particular quality is very rarely determined by a single gene, but there are cases where the transfer or alteration of a single gene can change particular qualities, either in a plant or occasionally in an animal.

The term "genetic modification" when applied to food refers to any artificial alteration in the genetic makeup of a food, animal or plant, or to the use of genetic engineering techniques in the production and manufacturing of food. It therefore covers a whole range of techniques.

Some changes may be quite subtle. For instance, an animal may be dosed with a hormone which is essentially identical to one that is produced naturally, but which has been manufactured artificially in large amounts in the laboratory using genetic engineering techniques. This is only altering that animal's physiology, not its genes. However, the food from that animal (its meat or milk for instance) has been genetically modified. *Bovine*

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1 The general issues, and the legislation relating to the release of GM organisms are discussed in more detail in an earlier Library Paper : Genetically Modified Organisms, Transgenic Animals and Animal Patenting, Library Research Paper 93/55

Somatotropin would be an example of this type.

Alternatively, the genetic makeup of an animal or plant may be changed. A gene can be removed and isolated, amplified or copied many times over, altered, and finally reinserted into animals or plants. Various techniques for achieving this have been developed. To give just a few examples here, molecules called "restriction enzymes" can be used to precisely chop up DNA and isolate the stretch of DNA or gene of interest. A technique known as the polymerase chain reaction (PCR) might then be used. PCR has revolutionised genetic engineering. Typically, the amount of DNA isolated from an organism (or recovered from a scene of crime by forensic scientists, or extracted from an insect fossilised in amber) is minute and thus very difficult to work with. PCR provides a way of amplifying fragments of DNA by copying them over and over again millions of times in the test tube.

The information contained in the genes, the DNA itself, may be altered through a technique such as "site specific mutagenesis". (Scientists can use agents such as radiation or chemicals to change DNA, but these cause random mutations of little use. Site specific mutagenesis provides a means of targeting precise changes at chosen sites.) Finally, the natural properties of very simple viruses might be used to deliver modified DNA into a host's cells. Alternatively, modified genetic material might simply be injected into an animal's just-fertilised eggs under a microscope; changes inserted at such very early stages of embryo development will be present in every cell of the adult animal.

"Copy genes" do not have to be put back into the same type of animal or plant from which they were extracted. They might originate from one organism and be inserted into another species altogether. Bizarrely enough, this transfer can take place from an animal to a plant, so that an animal gene is copied into a plant, or *vice versa*. Any animal or plant which carries genes from another species is known as a "transgenic" organism.[2] **However, it is very important to note that only copies of the information contained within genes are inserted in all cases; the original genes themselves are not transferred.**

Important applications have already been developed. Plants can be genetically modified to confer resistance against pests or so as to remain edible longer before becoming mouldy. Such genetic modification might reduce the need for pesticides or it might merely benefit the retailer. Animals can be genetically modified so as to gain qualities that are advantageous to the farmer or consumer. Pigs could be genetically modified so that they go on and on eating because their body no longer gives the signal that they are full up. Already in 1993 salmon that were artificially modified to make them sterile were going on sale in UK supermarkets. A newspaper commented : "In contrast to the salmon's natural image, the

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2 For further details, see Library Research Paper 93/55, *Genetically Modified Organisms, Transgenic Animals and Animal Patenting*

genetically altered variety is deprived of its instinct to migrate upriver from the sea to spawn. Such fish would stay put and grow to twice the normal size of farmed fish".[3]

Pigs can be treated with genetically produced porcine somatotropin (a naturally occurring pig hormone) so that their meat is leaner and healthier for human consumers. Similarly, cows can be treated with genetically produced bovine somatotropin (a cow hormone) so that they produce more milk. In such cases, the genetic makeup of the animals themselves has *not* been altered but their body physiologies have been altered through the application of genetic engineering techniques; genetic engineering has played a part in the food manufacturing process.

B. The British system of control

Regulation has been undertaken at a national level, although this is about to be replaced by control at the level of the European Union. The British Government position on GM food was stated in the summer of 1996:[4]

> **Mrs Browning :** The UK has a well established and internationally respected system for the approval of novel foods including genetically modified foods. The safety of novel foods is assessed by the Advisory Committee on Novel Foods and Processes, an independent body of experts set up to advise Agriculture and Health Ministers, and the need for labelling by the independent Food Advisory Committee. The Government support the concept of an EU regulation on novel foods and novel food ingredients and are actively participating in discussions on the details.

In the UK, the need for GM food to be labelled is assessed by the Food Advisory Committee on a case by case basis, as part of the approval process for their use. The Food Advisory Committee is a non-statutory body (comprising a chairman and fourteen members) whose members are appointed for their personal expertise and not to represent particular interests. The committee advises the Government on the composition, labelling and advertising of food, and on additives, contaminants and other substances that are, or may be, present in food or used in its preparation.

There are several stages of control in the UK. A company wishing to develop a GM food might first need consent from the Health and Safety Executive which can provide "contained

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3 *Sunday Times*, 16 September 1993

4 HC Deb 18 July 1996 c.633W

use consent" for a strictly contained experiment. The next stage (for a living organism) would be a "deliberate release consent" for planting the new crop in a field for research purposes. Until now, the involvement of MAFF has been through a voluntary process. The grower would be advised to apply to MAFF for approval for using the GM plant for food. That would be considered by the Advisory Committee on Novel Foods and Processes (ACNFP). After this, a marketing consent from the DOE would be required for a living organism. Thus, for example, tomato paste made from the American GM tomato (the flavr savr tomato) could be sold in the UK without such a consent, but the original tomato would have required a DOE marketing consent. The DOE marketing consent applies to the whole of the European Union, and can only be given after the DOE applies to the European Commission, which consults with the other Member States. The new EU Regulation, described in Part IIA, would basically make the MAFF process compulsory requiring a pre-market safety assessment from the competent authority, which in this context would be the ACNFP.

C. The Polkinghorne Report and Government policy

The Government set up a committee on the ethical problems involved in GM food, under the chairmanship of J. C. Polkinghorne, a distinguished physicist and clergyman. The report appeared in October 1993.[5] The committee did not cover issues of animal welfare or food safety but examined techniques and discussed whether labelling should be required. Their conclusion was a compromise between the strong desire of consumer and religious groups for labelling to allow informed choice, and the reluctance of the industry to accept this. The report argues that "copy genes" of animal or human origin do not merit a special ethical status, and therefore do not need to be identified in food.[6] However, the report continues:[7]

> Nevertheless, it is quite clear that our perception is not shared by many of the groups from whom we received evidence. We believe, therefore that the **first and most important requirement is for a system of labelling which permits informed choice in relation to the presence of ethically sensitive transgenes in food.** We believe this implies that labelling should apply to copy genes of human origin, copy genes originating from cattle and pigs introduced into other farm animals, and copy genes of animal origin introduced into plants or micro-organisms. This list should be kept under review and consideration given to its extension...

This conclusion was accepted by the Food Advisory Committee who were looking into the more general issues of labelling genetically modified food. The Government announced its

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5 *Report of the Committee on the Ethics of Genetic Modification and Food Use*, HMSO 1993

6 "copy genes" were defined on p.6

7 para 5.4

decision in a reply by Mr Soames:[8]

> The Food Advisory Committee takes the view that it would be unrealistic to label every food whose product has involved genetic modification. It has however accepted that there should be provision for choice in relation to those foods which raise real concerns for a significant proportion of the population. It has therefore proposed that a GM food should be labelled if it:
>
> (a) contains a copy gene originally derived from a human;
>
> (b) contains a copy gene originally derived from an animal which is the subject of religious or dietary restrictions; or
>
> (c) is a plant or microbial material and containing a copy gene originally derived from an animal.
>
> These rules would not apply if the inserted copy gene had been destroyed by processing and was not, therefore, present in the food. I am grateful to the committee for its careful and thorough handling of the issues. It is continuing its work, in particular in the form of labelling that might be used. Meanwhile, its advice coincides very closely with that of the Polkinghorne committee and I propose to accept it. The Government will therefore seek provisions on these lines in the proposed novel foods regulation which is currently under discussion in Brussels. Since very few GM foods have yet come on the market and public understanding of the technique is still limited, we shall also seek a provision for a review in a few years' time.

The Food Advisory Committee considered the matter a little further:[9]

> 11. The Committee then went on to consider the appropriate *forms* of labelling which might be required to indicate the presence of copy genes in a foodstuff. The Committee felt strongly that, if the criteria for labelling were met, the requirement for a labelling declaration should be a statutory one. It did not consider that labelling could be satisfactorily achieved by other means, such as non-statutory guidelines.
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> 12. Based on the evidence which the consultation exercise produced, the Committee considered that the primary concern of consumers was to be able to identify when a copy gene likely to be a cause of concern to a significant proportion of the population was present in a foodstuff. This was reflected in the criteria which it recommended should trigger a labelling declaration. As far as the form of labelling was concerned, it concluded that what was required was a simple declaration - "contains copies of x genes" (where x is human, pig etc). For single-ingredient foods and foods sold loose, it considered that the declaration should form part of, or accompany, the name under which the food was offered for sale. For prepacked foods with ingredients that contained copy genes, it recommended that the statement should be required to accompany the name of the ingredient in the list of ingredients. However, the Committee considered that if the copy gene was present in an ingredient which under current

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8 HC Deb 4 November 1993 cc313-314W

9 Food Advisory Committee Annual Report 1993

> rules did not need to be listed, the declaration about its presence should nevertheless be made, either in the ingredients list or next to the name of the food.

The Food Advisory Committee decides about the labelling requirements on a case by case basis, according to these criteria.

D. The Banner Report on animal breeding

Concerns about genetic modification go well beyond food safety and labelling, so the Government set up another committee, again chaired by an academic clergyman, (this time Professor Banner) to look into ethical implications of the use of GM techniques in animal breeding.[10] The first two recommendations were general :

> **General Principles**
>
> (1) that the following principles be accepted as a framework within which present and future uses of animals should be assessed.
>
> > (a) Harms of a certain degree and kind ought under no circumstances to be inflicted on an animal.
> >
> > (b) Any harm to an animal, even if not absolutely impermissible, nonetheless requires justification and must be outweighed by the good which is realistically sought in so treating it.
> >
> > (c) Any harm which is justified by the second principle ought, however, to be minimized as far as is reasonably possible.
>
> **Intrinsic Objections**
>
> (2) That an advisory standing committee be created, whose remit should include a responsibility for broad ethical questions relating to current and future developments in the use of animals.

There are nine recommendations relating to animal welfare, but these are more detailed. There are two on patenting - that developments should be monitored in relation to the threat to small producers posed by widely drawn patent protection and that the draft EU Directive on the legal protection of biotechnological inventions should be supported as it relates to animals. There follow two recommendations relating to the environment.

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[10] Report of the Committee to Consider the Ethical Implications of Emerging Technologies in the Breeding of Farm Animals, (HMSO 1995) (The Banner Report)

Genetic modification and environmental risks

(15) That the government continue to support international understanding, harmonization and co-operation on the control of genetically modified organisms.

(16) That the Advisory Committee on Release into the Environment (ACRE) should continue to scrutinize applications for release or marketing of genetically modified organisms on a case-by-case basis and impose restrictive conditions until research or experience has provided sufficient data on the impact of releases to allow any relaxation of those conditions.

The final recommendation related to genetic diversity, stressing the need to consider the conservation of farm animal breeds.

The Government accepted the general principles of the Report, but felt that the existing advisory bodies (such as the Animal Procedures Committee and the Farm Animal Welfare Council) could advise on ethical questions.[11] Most of the other recommendations were either accepted or referred for more detailed consideration by interested bodies such as the Royal College of Veterinary Surgeons. Those relating to the environment were accepted.

11 MAFF News Release, 28 February 1995

II Some Changes Currently Taking Place

A. The New EU Regulation

It is generally agreed that the regulation of GM food should be undertaken at an EU level, while worldwide regulation would ultimately be desirable. Otherwise any country trying to impose stricter controls than the rest can only do so by adopting restrictions upon imports. Indeed, even EU action does not avoid this problem, since the USA is sometimes more willing to authorise GM than Europe, partly because their procedure is carried out by the Food and Drugs Administration (FDA) which sees the issues as purely scientific and does not get involved in broader questions of public attitudes or economic disadvantages. It remains unclear whether in practice the European Union can ban the import of GM produce from the USA without provoking a serious trade dispute, but it is clear that such action could not in practice be undertaken by each individual country without seriously disrupting international trade flows.

The EU has just agreed on measures covering the use and labelling of GM food, with the European Parliament final vote in favour on 16th January 1997, after a lengthy conciliation procedure between the Parliament and the European Council.[12] The Regulation now has to be published in the Official Journal and will then come into force after 90 days. The EU Regulation will not greatly affect the position in the UK over rules for the approval of genetically modified food, in that the application will be considered by a committee in each Member State very much like the ACNFP. This was stressed in the UK Government Explanatory Memorandum:[13]

> Unlike most Member States, the UK already has an established clearance system for novel foods and processes, operated on a voluntary basis since 1989 by the Advisory Committee on Novel Foods and Processes. The Government announced in 1990, during the passage of the Food Safety Bill, that in view of the range of novel foods being developed and the likely increase in the use of genetic modification in the development of such foods, the ACNFP clearance system was to be put on a statutory basis. However, as the Commission indicated it was developing this proposal, the introduction of a national measure was held in abeyance.

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12 Amended Proposal for Regulation of the European Parliament and Council on novel foods and novel food ingredients, EC Draft 7983/96

13 EC Draft 7983/96

An answer to a PQ in 1995 explained the consequences of the proposed measures for labelling:[14]

> **Mrs. Browning :** The draft EC regulation on novel foods and novel food ingredients currently under discussion in Brussels will introduce compulsory labelling to indicate the presence in a food, including genetically modified foods, of ethically sensitive material, material which may have health implications for certain sections of the population and the presence within the food of a genetically modified organism, as defined by directive 90/220/EEC, if it has not been modified solely for agronomic reasons.

This latter exemption from the labelling requirement is important. Basically it means that crops that are modified so as to have some different behaviour when growing but to produce the same food at the end need not be labelled. The legal expression of that notion is, of course, more complex. Crops which are genetically modified, for example, to be drought-resistant or resistant to a herbicide would be covered by the exemption. They would not come under this exemption, however, if the actual crop was substantially different from the natural version. Under the rules proposed by the Commission, the GM soyabeans currently the focus of concern - and discussed in section IIC - would not need to be labelled, since they were modified to make them resistant to a herbicide, not to alter the final food.

B. Bovine Somatotropin

Bovine Somatotropin, known as BST in Europe and Bovine Growth Hormone or BGH in the USA, is a naturally-occurring hormone, which can be synthesised by GM techniques. It can be administered to cows to improve milk yields. Its use has been licensed in the USA by the Food and Drugs Administration, which saw it as a scientific issue, and was satisfied by the evidence that there was no danger to consumers and no animal welfare problem. Its use has been banned in Europe until 31st December 1999, except for limited practical tests to obtain any additional scientific data that might be taken into account in taking a final decision on its authorisation.[15] The decision in Europe was taken by Agriculture Ministers and took other factors into account, including the wisdom of increasing dairy output in a sector where there is already overproduction, the possible negative reactions of consumers, and the possible benefits to large dairy producers who would have the resources for the new techniques. More recently, concerns have been raised about animal welfare, but it remains unclear whether they will turn out to be soundly based.[16]

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14 HC Deb 14 July 1995 c.853W

15 *New Scientist*, 20 December 1994

16 The background is discussed in an earlier Library Paper : Bovine Somatotropin, Library Research Paper 93/101. The animal welfare question is discussed in : Arguing till the cows come home, *New Scientist*, 29 October 1994

C. Soyabeans

In March 1996, the US company Monsanto was given approval to market processed genetically modified soyabean in the EU. The UK part came under the *Genetically Modified Organisms (Deliberate Release) Regulations 1992*, as amended.[17] The journal *Agra Europe* reported:[18]

> EU member states have given approval for products obtained from genetically modified soyabean to be sold on the EU market... *Round-Up Ready* soyabeans, produced by US agrochemical company Monsanto, are genetically modified to be resistant to Monasanto's herbicide Round-Up. Under the EU's authorisation procedure, national experts from the fifteen EU member states were required to send their opinions on the soyabean to the Commission by last Friday [15 March 1996]. The product received approval by a qualified majority of member states, with Denmark, Sweden and Austria voting against and Luxembourg abstaining.
>
> The decision will enable US farmers to go ahead with planting plans in April and May. The US exports 60% of its total soyabean crop and soyabean producers are expected to plant around 1-2% of their total crop with the genetically modified strain...

The name "Round-up ready" refers to the fact that the beans are engineered to be resistant to the herbicide "Round-up" also produced by Monsanto. Therefore farmers can use round-up to kill weeds without killing the soyabeans.

The issue has caused particular controversy because Monsanto and the American Soyabean Association have decided not to segregate GM soyabean from the conventional crop.[19] This means that any imported from the US may contain modified soyabean and so it is not possible to definsoyabeanitively label food as containing or not containing modified soya. Greenpeace described the decision as "genetic pollution" and said that the industry "was using the European consumers as guinea pigs" whereas the industry claimed there would be environmental benefits, as the use of herbicide would be reduced by 30-40% .[20]

In the UK food manufacturers and retailers have decided that they could not avoid the use of the GM soya in a wide range of products, and that they cannot label products according to whether they contain GM beans. In Germany, on the other hand, consumer opposition has been stronger, and the market leaders in food manufacturing, Nestle and Unilever, have reacted to this pressure by making a commitment to avoid the use of GM soyabeans. Nestle

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17 HC Deb 18 November 1996 c.448w

18 *Agra Europe* 22 March 1996 pp E/3-4

19 "European retailers stand up to US soya producers" *ENDS Report* September 1996

20 ibid

Deutschland, with a turnover of 7bnDM uses only 2,000 tonnes of soyabeans in a year, and said that they could easily obtain that from sources other than the USA.[21] This is a business decision and not because the law is stricter in Germany. In Britain, most products containing soya, including bread, margarines, and chocolate will contain a small unlabelled proportion which comes from genetically engineered beans. The Consumers Association has called on the Government to force producers to label items which could contain the altered soyabeans.[22] A newspaper reported Diane MacRae, of the Consumers Association, as saying :"I think it's a scandal that Unilever and Nestle are not prepared to give British consumers the same choice they are giving to their German counterparts."[23]

D. Maize

GM maize, like GM soya, has been approved in the USA and mixed in with the normal crop. However, unlike soya there were fears that it would come to Europe before being approved in its unprocessed form. There was greater concern about the GM maize, partly because of the insertion of the gene for resistance to the antibiotic ampicillin, leading to fears that the gene could find its way into the gut bacteria of livestock and people (see p.15). In this case, the company which developed the product inserted the resistance gene in order to be able to measure the spread of the GM maize, but critics fear that the consequences would be both important and potentially harmful.[24] The GM maize had already been approved in Europe for incorporation in processed products (such as corn flakes) but not for sale in unprocessed form. However, at the last minute, the EU agreed to approve the GM maize, on the advice of its scientific committees.[25] Although that approval defuses the particular problem of this GM maize, the more general concern remains that Europe may not be in a position to resist the import of a product that secures US approval.

The Secretary of State for the Environment (Mr Gummer) was reported on December 5th 1996 as having expressed concerns on the radio:[26]

> It is true that the Americans are trying to force this on to Europe without us making our own minds up about it...One of the important reasons for the EU is that we are strong enough to say to the Americans that "We decide what we want in our food chain and not you."

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21 *Frankfurter Allgemeine Zeitung*, 14 November 1996
22 *Independent*, 12 November 1996
23 *Guardian*, 11 December 1996
24 *New Scientist* 6 July 1996
25 *Agra Europe*, 20 December 1996 E/4
26 *Independent*, 5 December 1996

As with soyabeans, the problem is that the American growers have mixed the GM plant with the normal maize, making it virtually impossible to distinguish the two.[27] If Europe therefore had decided to ban the import of all US maize there would have been implications for world trade. The USA would almost certainly have complained to the World Trade Organisation (WTO). There is a possible defence in Article X of the Gatt (General Agreement on Trade and Tariffs) for a ban on imports (very similar to Article 36 of the Treaty of Rome).

The relevant part of the Gatt reads as follows:

Article X

> Subject to the requirement that such measures are not applied in a manner which would constitute a means of arbitrary or unjustifiable discrimination between countries where the same conditions prevail, or a disguised restriction on international trade, nothing in this Agreement shall be construed to prevent the adoption or enforcement by any contracting party of measures :
>
> (a) necessary to protect public morals;
>
> (b) necessary to protect human, animal or plant life or health;

It is unclear whether a defence would be accepted on the grounds that a GM plant was a danger to human, animal or plant life or health. If not, the EU would be faced with a choice of whether to accept the GM plant, regardless of concerns, or to refuse to comply and to risk trade sanctions approved by the WTO. It is important to note that the WTO disputes procedure is more serious than its predecessor under the Gatt. If a Gatt panel ruled against a country, that country could veto the conclusion and prevent any action from being taken. Under the WTO system, unanimity of member countries is not required before action so such vetos cannot be used.

Since the EU approved the GM maize, the Austrian Government has announced that it will impose a unilateral ban on its import.[28] The Austrian authorities, through the procedure laid down in Article 16 of Directive 79/112/EEC on the labelling of foodstuffs, notified a draft decree concerning the labelling of foodstuffs, including additives produced through genetic engineering. The draft requires the words "produced through genetic engineering" to be placed on the labelling of any foodstuff which is, or contains, a genetically modified organism. The Commission has pointed out that the notified draft runs counter to the labelling provisions laid down in the common position on the proposed EU Regulation, and proposed a Council Decision stating "that it would be preferable if the Austrian authorities

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27 ibid

28 *Nature*, 2 January 1997

refrained for the moment from adopting the draft decree".[29] If the Austrians go ahead further legal action is likely because of the need to ban imports of US maize and soyabeans, where there is no labelling. Presumably this will rely upon Article 36 of the Treaty of Rome, but it is difficult to see the role of a unilateral ban within a Union which is moving fast to remove all internal frontiers.

The reason for objections to the GM maize is that it contained a gene, for an enzyme called beta-lactamase which destroys ampicillin, an antibiotic in the penicillin family. Scientists in Ciba-Geigy, the company which developed it, used the gene to determine whether plants had been genetically modified or not. The main critic has been Tony Atkinson, of the drugs company Duramed, an ACNFP member, who fears that beta-lacramase will jump from corn to bacteria in an animal's intestine:[30]

> "No one has yet looked at the effect of feeding a gene to lots of animals day in and day out for years," he says. Ciba argues that up to 10% of human gut bacteria already contain the beta-lacramase gene, and that there are other antibiotics which are not destroyed by the enzyme. But Atkinson notes that the gene in the new maize is coupled with a stretch of DNA which causes cells to make 600 copies of the gene. This will not only make it more likely that a gene will eventually jump from maize to bacteria. It will also mean that once it does jump, the bacteria might produce the enzyme in large enough quantities to destroy a wide range of beta-lactam antibiotics.

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29 Proposal for a Council Decision requesting the Republic of Austria to refrain from adopting its draft Order on the labelling of foodstuffs produced by genetic engineering, 13021/96

30 *New Scientist*, 4 January 1997 p.8

III Some Issues Relating to GM Food

A. Is there a danger to consumers?

In a sense the concerns relating to the health of consumers centre upon fears that the GM food is not, in fact, really equivalent to the natural version, but differs in some important aspect which could cause problems. An article by a former director of science at Greenpeace UK challenged the assumption that a GM food can be equivalent to the natural variant:[31]

> Regulators say Monsanto's soyabean is safe because it is "substantially equivalent" to natural soyabean. Substantial equivalence is an OECD concept used to decide if things are sufficiently different to raise concerns over safety or labelling. It compares the chemical composition of novel foods with their natural counterparts, for example. But the soyabean has unquestionably been genetically engineered, contains foreign genes and produces a novel protein. Unexpected food allergies can not be ruled out. This together with the likelihood of increased herbicide use and perpetuation of intensive agriculture has led environmentalists to a different conclusion. Genetically engineered soyabean is not the same as traditional soyabean. Laboratory tests of "substantial equivalence" do not pick up what may prove to be the most critical differences.

One example that opponents of GM food often use is that of tryptophan. Tryptophan is an amino acid which occurs naturally in foods such as milk and cheese where it is harmless, and is indeed essential to the diet. However, in the late 1980s genetically engineered tryptophan was added to other products, and also sold in tablet form as a dietary supplement to aid sleep and combat premenstrual tension. Hundreds of cases of illness and 22 deaths in the USA were attributed to this supplement which was then banned. The problems stemmed from a few batches of L-Tryptophan made by a single manufacturer, Showa Denko, in Japan.[32]

Opponents of GM food claim that the tryptophan episode shows that something which passes all the tests and seems completely harmless may, nevertheless, cause serious damage to consumers. A study of the episode describes what happened.[33] Almost all of the cases of eosinophilia-myalgia syndrome were associated with the consumption of tryptophan made by a single company:

> This company used a fermentation process involving *Bacillus amyloliquefaciens* to

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31 *New Scientist*, 30 November 1996 p.51

32 *New Scientist*, 23 November 1991

33 E.A.Belongia et al., An investigation of the Cause of the Eosinophilia-Myalgia Syndrome Associated with Tryptophan Use, *New England Journal of Medicine*, 9 August 1990

> manufacture tryptophan. Analysis of the manufacturing conditions accorded to the retail lot use demonstrated an association between lots used by case patients and the use of reduced quantities of powdered carbon in a purification step...as well as the use of a new strain of *B. amyloliquefaciens*...There was a significant correlation between the reduced amount of powdered carbon used during manufacturing and the use of the new bacterial strain....
>
> Conclusions. The outbreak of eosinophilia-myalgia syndrome in 1989 resulted from the ingestion of a chemical constituent that was associated with specific tryptophan-manufacturing conditions at one company. The chemical constituent represented by peak E may contribute to the pathogenesis of the eosinophilia-myalgia syndrome, or it may be a surrogate for another chemical that induces the syndrome.

It appears that the problem came from specific aspects of the manufacturing process in Showa Denko, rather than from the fact of the tryptophan being genetically modified. That probably suggests the need for greater care in checking GM applications rather than banning all GM food. However, critics might suggest that the tryptophan episode illustrates the risk that there will be some aspect of the final product which is different in a way that does not appear in the tests. Therefore they would argue that the process of genetic modification does produce risks to consumers.

B. Consumer Attitudes

1. Germany

German hostility towards GM food partly reflects the high German concern over environmental matters - as reflected for example in their strong reaction to the planned disposal of Brent Spar in the sea.

A recent study asked German consumers whether they would buy a range of foods, produced with the help of GM techniques.[34] All had unfavourable reactions. The least unfavourable was for marmalade, whose glycosyrup was made by means of an enzyme, produced with the help of a GM microorganism. 38% would buy it and 42% would not buy it. 32% would buy a potato, made with a bacterium which meant that it absorbed less fat in roasting, but 48% would not. Only 26% would buy eggs from hens which had been fattened by means of a GM enzyme, even if the purpose was to cause less damage to the environment, and 52% would not buy them. Only 14% would buy meat from animals which had been genetically modified to grow larger and more quickly. 71% would not buy it.

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[34] WBA Institut für Marktforschung und Marketingberatung; quoted in *Wirtschaftswoche*, 28 November 1996 p.109

2. The UK

In 1994 a consensus conference on plant biotechnology was held in the UK. A "lay" panel was selected from volunteers from the general public. The panel was briefed on the topics, and then developed a few key questions on which the consensus conference paper was based. Some of their opinions are inevitably generalities. The panel felt that biotechnology offered the consumer several potential benefits : improved taste, better nutritional values, longer keeping properties, variety and consistency of quality. However, the panel also noted possible objections, including to the use of plant material containing animal genes, and fears about possible allergens resulting from added genetic material:[35]

> At the more general level, the panel felt that the public could only freely exercise its right to choose if it knows that products concerned have been genetically engineered...From the consumer's perspective, the panel felt that the products currently reaching the market were ore the result of researchers and producers creating a market for their products, rather than the market expressing a need or desire for them.

C. Will GM plants mean more or less pesticide use?

The obvious view is that plants can be genetically modified so as to be safe from particular sorts of pests, so that use of pesticides will decline. Some people doubt that, however, partly because they see the same multinationals selling pesticides and having the capacity to produce GM plants. It could be in the interests of a company to develop a GM plant which was protected from its own brand of pesticide. That pesticide could then be used to kill weeds, but without killing the GM plant. The company could then get its customers to buy both items. Unless they bought the company's GM seeds, they would not be able to use the company's proprietary pesticide. The result could conceivably, therefore, be an increase in pesticide use, because farmers could now use pesticides which would otherwise damage their crops. These issues are raised in the case of the soyabeans genetically engineered to be resistant to "Round-up". Monsanto claims that this will enable farmers to use the convenient "Round-up" rather than a greater quantity of other pesticides. Critics would claim that pesticide use might increase instead.

To some extent, one's reaction to such possibilities may depend upon one's attitude towards the activities of large international companies. Those who disapprove of them will tend to expect the result of GM food to be increased pesticide use, because that makes profits for the company. Those who consider such companies to have a broadly positive influence, will tend to stress the other possibilities, involving lower pesticide use and higher output.

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35 Plant Biotechnology - A Consensus ? *POSTNOTE 56*, January 1995

D. Will the Third World Benefit?

The GM techniques have mainly been developed by Western multinationals, particularly in the USA - with the important exception of China, whose role is discussed below. They will be patented, so that users will have to pay for them. That might exclude farmers in poor countries who would be unable to afford the seed. A further fear is that such a strategy could mean that the benefits would go to richer farmers who could buy the whole package. Farmers in poor countries would only benefit if they abandoned their traditional seeds. Such a move would be undesirable for them, partly because of cost, partly because of loss of genetic diversity, partly because their own seeds are better developed for local conditions. Once farmers are lured into the world of bought-in seeds from international companies and accompanying pesticides, there is no way back. The local varieties become lost, but the farmers cannot re-use their surplus seeds for sowing, since they have to buy new from the company. Critics therefore see genetic modification as part of the whole process whereby Third World farmers get caught in the cash economy, since they need cash to buy their seeds and must therefore obtain cash by selling their crops.

Another issue is that it may not be profitable for a company to develop, for example, a better crop for sub-Saharan Africa, but instead to develop a luxury crop for the New York market. Indeed, genetic techniques might enable crops in developed countries to replace imports from the Third World, for example by providing longer seasons so that there was no longer a gap to fill by imports.

Multinationals may never be able to satisfy their critics. Many people would blame them for replacing Third World imports, but others already blame them for encouraging the spread of cash crops in the Third World. Similarly, they can be criticised either for not producing a crop suitable for Third World use, or for encouraging Third World farmers to abandon their traditional crops in favour of new ones. Yet there is potential for helping the Third World, and the spread of GM techniques may make it easier for groups other than cash-rich multinationals to undertake the development.

E. Do we need genetic modification to feed the world?

The serious justification for GM food, of course, is the argument that the growing world population can only be fed by means of a steady growth in agricultural productivity. The debate on GM tends to assume that the motivation is simply to increase the profits of multinational corporations. Although in a sense that is the reason why corporations do things, that approach often excludes the enormous potential benefits of the new processes. For example, if crops could be genetically engineered to be drought resistant, then output could

be greatly increased in dry parts of the world.

Attitudes towards world food supplies tend to vary between panic and complacency. Previous panics have fortunately not been justified by events and there is perhaps a widespread belief that despite enormous population growth, crop yields will continue to increase automatically to outstrip the growing demand. In practice, of course, the increase in output has to be achieved - whether by the use of more land, the more productive use of land (for example irrigation), or scientific research to develop better seeds. The majority view seems to be that supply will continue to grow in line with demand, although a minority view is that the scope for increases in output are by now limited. There is general agreement, however, that a considerable amount of scientific research and development will be required in order to increase yields.

A recent report from the International Maize and Wheat Improvement Centre in Mexico has set a goal of increasing wheat yields by an average of 2.5% a year. In the 1960s and 1970s, the so-called green revolution boosted yields enormously, but for the past decade they have only been increasing at around 0.5% a year.[36] The recent conference of the Consultative Group on International Agricultural Research (CGIAR) was optimistic about the scope for improvements and felt that supply increases could satisfy demand. The importance of genetic engineering was stressed, as well as the need to tailor the new crops to the needs of poor rural farmers.[37]

F. The Importance of China

China is important, partly because there might be shortages of food there, and partly because they have already gone ahead with the testing of GM crops, apparently without all the regulatory controls undertaken in the West. In January 1993, it was reported that China had begun testing GM tobacco, potatoes and tomatoes on plots covering several square kilometres, a far larger area than had then been tried in the West. The idea that GM techniques will be the monopoly of large Western companies may not be correct. According to the *New Scientist*, "It doesn't take much more than a couple of clever well-trained people and some quite inexpensive equipment to set up a biotechnology laboratory".[38]

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36 *New Scientist*, 26 October 1996

37 *New Scientist*, 9 November 1996

38 *New Scientist*, 2 January 1993

Lester Brown has argued that the food needs of China will soon come to dominate the world grain market.[39] There are several reasons why he sees China as unable to increase production enough to satisfy its demand. Output may be increased by better varieties of crops, by the use of more fertiliser, by using more land or by the application of more fertiliser. Yet on each count Brown sees either no scope for improvement or a likelihood of loss of output. There is some steady progress in developing strains of crop but there has been little dramatic improvement for some time. Fertiliser application in China is already very high and there are signs that its use already exceeds the optimum level. Land availability is a serious problem in China where much of the land is unable to be cultivated. Industrialisation places severe pressure on cropland, through demand for housing, factories and roads.[40] Water is a considerable problem, partly because most of China's water is in the south and most of its wheat is grown in the north.

The limitations on China's ability to increase supply contrast with the likely increase in Chinese demand. This partly derives from predicted population increases. Despite a vigorous policy aimed at limiting each household to one child, population is likely to increase by 490 million between 1990 and 2030. Growth is projected to slow down after around 2015, with the population peaking at around 1.66 billion in 2045. In addition, however, as people become richer, they almost invariably eat more fish and meat.

A contrary view - and closer to the consensus - comes from Professor Tim Dyson, who is cautiously optimistic on the prospects for world population and food supplies up to the year 2020. He sees no reason to doubt the continuation of yield improvements in cereals:

> The average annual increment in world cereal yields since the early 1980s has been about 42kg per hectare per year. This is actually slightly higher than the long-run average increment during 1951-93. There has been no obviously worrying yield "slowdown". There is every reason to expect that in all world regions average cereal yields will be markedly higher in 2020 than they are today; and a global average yield of around 4 metric tons in 2020 seems a perfectly realistic expectation...

Dyson is far more optimistic about the scope for increasing cereals output in China. He stresses uncertainty about even the present Chinese position but does not share Brown's concern :[41]

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39 Lester Brown, *Who will feed China* ? (1995)

40 op. cit., p. 57

41 op. cit., p.188

> There has actually been very little change in China's area harvested of cereals since the early 1980s - partly due to increased multiple cropping (especially in south China). The same is true throughout the region. It is far from clear that China's irrigation capacity is under any immediate threat. Indeed, even some of the basic facts of Chinese agriculture are uncertain. For example, there are indications that the country's true levels of cereal production and food stocks could be larger than has hitherto been thought.

He estimates that the Far Eastern region will need to achieve an average cereal yield of about 6 tons by 2020, and considers that feasible, partly because Japanese yields are already nearly at that level, partly because Chinese yields, although well below, have been steadily rising since 1951. Dyson feels that most of the advances up to the year 2020 can be made by the application of already existing technology to agriculture.[42] It therefore remains unclear how important will be the role of GM technology in boosting food production over this period. However, further increases in population will put increasing pressure on world agriculture and make increasing demands on the technology.

In June 1996 The Chinese Government announced a major five year programme of support for research projects, with agriculture playing an important role, including proposals to increase crop yields, promote intensive farming, as well as research into pesticides and fertilisers.[43]

G. Conclusion

GM techniques offer major potential benefits, although critics remain concerned about safety and environmental issues. Many factors, which are mainly non-scientific, will determine whether the potential benefits are achieved. European reluctance to licence the new products risks trade conflicts with the USA, where such issues are seen in more scientific and less political terms. There can be no doubt that scientific advances will be required if the increasing population of the world is to be fed, although the role of GM techniques in the near future remains uncertain. Countries where increased production is a priority may adopt certain GM techniques while others retain doubts. In principle, however, GM techniques do offer the opportunity of considerable benefit, provided that they are not misused.

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42 Speech at the Oxford Farming Conference, 7 January 1997

43 *Nature*, 27 June 1996

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