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Assessing risk: science or art?[1]

Assessment of risk, which used to be seen as a purely technocratic process, has become much more complex as we have learned how hazards can be viewed so differently by scientists and members of the public. Social science research has shown how much the individual's own values affect their relative perception of risk and this insight has now been brought into the process of risk assessment. Many of the values that affect these judgments are of central importance to Christian faith, and this article seeks to show, with use of suitable examples, how the process has developed, and its implications for Christians.

Keywords; GM foods, GM crops, risk, hazard

Introduction

A few years ago, Ian Taylor, a well-regarded Minister for Science in the British Government, when faced with a difficult risk-assessment decision, said that he wanted 'a Richter Scale of risk'. By that he meant an agreed number that scientists could give him that would accurately represent risk, and which would be accepted by all. This turned out to be an impossible dream. Whereas at one time all scientists had to do was to decide that a novel food, a new medicine, or some innovative technology was safe and the public would accept their verdict, times have now changed. That leads me firstly to ask what has happened, secondly, is there anything that we can do about it, and thirdly and most particularly, what do we have to offer as Christians in such circumstances?

The way in which risk is perceived and assessed has changed very substantially over the last ten years or so. This change has taken place progressively and in this article I want to identify five successive stages in the approach to risk and risk perception over that period, offering specific examples by way of illustration.

The First Stage: the Technocratic Assessment of Risk

At one time, all that scientists working in the UK regulatory system thought they had to do was to make a technocratic assessment of risk, by working through a purely technical process that produced an agreed number to express the risk, often as a negative power of ten, and which expressed all risks on the same scale. However, this proved to be impossible in practice. They soon discov-

1 This article is based on a talk given to a *Christians in Science* conference in Sheffield on May 17th, 2003

ered that consumers saw risk differently from the way that most scientists did, for example over so-called genetically modified (GM) foods. Those scientists involved in the regulatory process learnt that different people have different value systems, which affect the way they view different risks, and that, since scientists do not always understand the views of the consumer or share their value systems, they cannot make decisions for them. One practical result of this was that the food regulatory process had to be widened to draw in the consumer.

I can illustrate this most easily by an example from my time as Chairman of the Advisory Committee on Novel Foods and Processes (ACNFP) from 1989 to 1997. This committee, of which I was the first Chairman, was responsible for advising Ministers in the British Government about the safety of all novel foods, including those derived by genetic modification. The Committee at that time consisted of sixteen experts in different fields of science relevant to the issues on which we had to give advice. The Committee worked by reviewing applications from the companies who wished to market the novel food, and then brainstorming as to what could possibly go wrong. This process often involved going back to the company concerned, asking for more scientific data, often actual experimental data, in order to ensure that all reasonable steps had been taken to identify anything that could harm the consumer in any way. The Committee was looking for any evidence of risk, but 'no evidence of risk is very different from evidence of no risk', a point that caused confusion later on. Nor had those involved grasped the importance of consumer perceptions or understood the very different way the consumer saw risk.

A case study: a genetically modified yeast

This difference in attitudes between scientists and consumers is well illustrated by the first product obtained by genetic modification to come to the ACNFP. In late 1988, the ACNFP was asked to approve the use of a genetically modified baker's yeast. The novel yeast, which had been developed by the Dutch company Gist-Brocades, involved changing the genetic make up of the original yeast so that it could utilise the simple sugar, maltose. This was done by introducing two genes from a similar, but not identical yeast, by straightforward genetic manipulation. The presence of the two new genes led to increased utilisation of maltose, which led in turn to more rapid production of carbon dioxide, and in turn to an increase in the rate at which the bread rose. This meant that the bread did not need to be in the oven for so long, less power was used, and this offered the baker a commercial advantage. This seemed a good case with which to start the reviewing process. After all, there is a naturally occurring yeast mating process which results in genes moving from one yeast to another, and such a process could have brought about the same change.

The ACNFP did not see any problem, and so advised the Minister[2]. In early

2 Advisory Committee on Novel Foods and Processes, *Annual Report* (1989), pp. 2-3. All ACNFP Annual Reports can be found on the Food Standards Agency website: www.food.gov.uk

1990 a brief Press Release appeared which announced 'The product may be used safely.' Press reactions varied widely. *The Times* reported: 'Genetic yeast passed for use', while *The Independent*'s headline read: 'Man-made yeast raises temperature'. *Today* weighed in with: 'Bionic bread sales wrapped in secrecy' and 'Mutant yeast is half baked way to slice up nature' and *The Star* asked 'Are the boffins taking the rise out of bread?' For its part the Consumers' Association said 'We think all genetically altered foods should be labelled'.

It is clear from these headlines that the media and the consumers saw a problem that the scientists were quite unaware of, and that issues of labelling and choice were already a concern. Indeed, so much public concern was aroused that the product has never been used: a harbinger of the problems that were to be encountered later.[3]

The Second Stage: the Role of the Consumer

All this alerted the ACNFP to a problem of which it had previously been unaware. That committee responded by gathering together, for a weekend conference in October 1990, representatives of all the groups who might be able to help it avoid this problem in the future. The conference included scientists, social scientists, a philosopher, a theologian, consumers and members of some of the alternative groups. As a result the Committee made a number of recommendations to Ministers.[4] The first of these was that membership of ACNFP should be broadened to include a consumer representative and an ethical adviser. It was further recommended that access to information should be improved by providing press releases briefly describing the agenda before meetings, and then afterwards outlining the outcome. The only recommendation not adopted at the time was that observers be allowed into ACNFP meetings. Additional measures advocated included the publication of advice to Ministers; the holding of an annual Press Conference and the production of an Annual Report. The Committee also recommended increased consultation with consumers, the provision of educational material, and research into consumer perception and food choice. Finally it urged that guidance notes on commercial confidentiality be drawn up and that the Food Advisory Committee (a sister committee) publish guidelines on food labelling.

These changes were quickly put in place, and they proved to be perfectly satisfactory until the advent of GM soya from Monsanto, a North American company which had recently moved into plant biotechnology. The genetic modification of the soya was quite modest, no more than the introduction of two genes

3 For a full description, see Kemp, R. 'Social implications and public confidence: risk perception and communication', In Stewart-Tull, D.E.S. & Sussman, M. (eds) *The Release of Genetically Modified Microorganisms – REGEM 2*, Plenum Press (1991), pp. 99-114, especially the outline of the way the social psychologists have mapped hazards.

4 Advisory Committee on Novel Foods and Processes, *Annual Report* (1990) Annex VIII. All ACNFP Annual Reports can be found on the Food Standards Agency website: www.food.gov.uk

from a common soil bacterium into a plant with about 30,000 genes, yet this product, although deemed safe by the ACNFP, was rejected by consumers. Why was this?

One very important reason was that consumers assess risk in a quite different way from scientists. The technocratic definition of risk is: the likelihood (or expected frequency) of adverse consequences from any hazard. That seems very straightforward, but it is not the way the public sees risk; it does not explain why some risks trigger so much more alarm, anxiety, or outrage than others, seemingly regardless of scientific estimates of their seriousness. Research over many years has identified a number of fright factors: factors which affect the way the public sees risk. Risks are generally more worrying if perceived:[5]

- to be involuntary (i.e. exposure to pollution) rather than voluntary (e.g. smoking);
- as inequitably distributed;
- as inescapable by taking personal precautions;
- to arise from an unfamiliar or novel source;
- to cause hidden and irreversible damage;
- to pose some particular danger to small children, pregnant women or future generations;
- to threaten a form of death, injury or illness arousing particular dread;
- to damage identifiable rather than anonymous victims;
- to be poorly understood by science;
- as subject to contradictory statements from responsible sources.

GM soya scored positively on most criteria on this list. But there was also a strong reaction against what was perceived as the economic hegemony of a large US multinational company and their unwillingness to label or to segregate the new product, so that consumers had no choice. It was easily represented as 'They are trying to foist on us by stealth things we do not want.' For, crucially, GM soya offered the consumer no advantage: the advantage went to the farmer and seed producer. So decisions that might possibly affect the health of British consumers, and certainly affected their ability to choose, were being taken in St Louis, Missouri, and consumers felt that they were losing control. But underlying all this was a deep suspicion of the trustworthiness of the regulatory process, stemming from the BSE (Bovine Spongiform Encephalopathy) disaster, which led to a loss of trust in politicians and associated government scientists. This distrust was fanned by the claims of Dr A Pusztai[6] that feeding rats with genetically modified potatoes caused them

5 Bennett, P. 'Understanding response to risk: some basic findings', In Bennett, P. & Calman, K. (eds) *Risk Communication and Public Health*, Oxford: Oxford University Press, (1999), pp. 3-32.
6 Ewen, S.W. & Pusztai, A., 'Effects of diets containing genetically modified potatoes expressing *Galanthus nivalis* lectin on rat small intestine', *Lancet* (1999) 354 (1), 353-354.

damage, and although these claims have never been substantiated,[7] a lingering doubt remained.

It is also true that people living in developed countries, particularly in Europe and North America, have become very sensitive to all risks, whether perceived or real, especially as other threats to safety recede. We live in a 'blame culture' where somebody is responsible, and culpable, for everything that goes wrong. 'Risk' is not a simple concept either: there is a difference between those risks we choose to take and those that are thrust upon us; and between risks linked to medicine and those linked to food. In consequence consumers want to make their own decisions, rather than trust the experts. And what are the reasons for this loss of consumer confidence in the experts? Let me suggest several.

- Scientists' judgments are no longer trusted as they once were. The BSE outbreak has been disastrous for confidence, because the assurances given by politicians, based on scientific advice, turned out to be fatally wrong.
- Scientists can only say that there is no evidence of risk, while the public is asking for evidence of no risk. That can never be supplied – with GM foods, mobile phones, or any other new technology.
- Scientists find great difficulty in explaining, and the public in understanding, what is meant by different degrees of risk. The British National Lottery had, as its slogan: 'It could be you', and the message was clear: even what is very unlikely might happen. So even if the risk from a new product is very low, maybe it will be me who suffers! It has to be somebody.
- Consumers are worried about the growth of multinational companies who now control markets globally. This means that decisions are often taken in another country or in another continent, and consumers feel that they have lost power, as indeed they have. So they turn to pressure groups, the Consumers' Association or any one of the environmental pressure groups, for help. These groups often represent their hopes and fears more articulately than anyone else, and they have considerable political influence.
- Risks are assessed differently according to the situation. We will accept quite high risks, when we are seriously ill, for example, by accepting a new drug, but we will not tolerate much risk at all with food.

One explanation for such conflicting views is that scientists and the public work from different value systems. Scientists and technologists see novel applications of new discoveries as logical and reasonable – and characterise all opposition as unreasonable. 'If only they understood what we are doing,' they say, 'the public would agree with us.' This is not often true. Scientists and tech-

7 For a careful review of all the published evidence and a substantial amount of new data which shows that two GM plant products (sweet pepper and tomato) are comparable to their non-GM counterparts in terms of food safety, see Chen, Z.L., Hongya, G., Yi, L., Yilan, S., Ping, W., Zhicheng, J., Xiaotian, M., Jinhua, T., Naisui, P. & Li-Jia, Q. 'Safety assessment for genetically modified sweet pepper and tomato', *Toxicology* (2003) 188, 297-37.

nologists are used to an uncertain world, where knowledge is always flawed; they can handle risk judgments more easily, and are impatient with those who differ from them. The public's reaction is quite different, and it can be described in quite different terms:

- Outrage – 'How dare they do this to us?' – the way the public now regards Monsanto.
- Dread – the way we would regard a nuclear power station explosion.
- Stigma – the way the public regards food radiation.

Peter Sandman[8] states the problem well: the risks that do damage according to the experts are not usually the risks that upset people. He then suggests four traditional answers:

1 *The conservative's answer*: The public is stupid and irredeemably irrational on risk issues. So we must protect public health, but ignore public opinion.
2 *The liberal's answer*: the public is educable but ignorant. So we must explain the data better.
3 *The company's answer*: the public is manipulated by sensational mass media or radical activist groups. So we must fight the propaganda battle better.
4 *The activist's answer*: the public is right; the experts have been misled or bought off. So we must base public policy on public opinion.

He then suggests a new answer: the experts respond to hazard; the public responds to outrage. When hazard is high and outrage is low, the experts will be concerned and the public will be apathetic. When hazard is low and outrage is high, the public will be concerned and experts will be apathetic. So if you, as a scientist, wonder why the public is responding as it is to some risk issue, then this is the outrage in action. Experts often define risk as *probability* × *consequences*. In contrast Sandman defines risk in a new way:

$$\text{Risk} = \text{Hazard} + \text{Outrage}.$$

It is an interesting approach.

The clear conclusion of this evidence from the social sciences is that it is not possible to predict the way in which the public will react to a new risk by consulting scientists and technologists alone, and from a pragmatic perspective the perception of risk is now as important as assessment of risk in the introduction of any new technology.

Although the public's reactions may seem unreasonable to some scientists, they cannot be dismissed as unreasonable *per se*. In fact they often reflect perfectly reasonable value judgments. Risk of death by cancer, for example, usually carries much greater dread than the prospect of a sudden heart attack. Risks which are freely chosen are also regarded quite differently. Indeed risk

8 Sandman, P. Personal communication. www.psandman.com

often has attractions: mountaineers, hang gliders and racing drivers take precautions to limit the risks they take, but facing some risk is undeniably part of the fun. The general point is that responses to risk not only depend on the context, but are also intertwined with personal values – a point well made by Adams.[9] Attitudes to specific risks are influenced by beliefs about how society is and should be, our relationship with nature, the benefits and disadvantages of technology, and of course religious belief. All will help determine which fright factors most frighten us and what sources, and forms, of information are to be trusted.

The Third Stage: Raising Ethical Issues.

But in addition to different attitudes to risk, another issue emerged, which was whether there were circumstances in which a proposed genetic modification was simply wrong, that is, ethically unacceptable. Here again the ACNFP found that some risks which seemed perfectly acceptable to scientists were unacceptable to consumers, this time because of ethical concerns. It was therefore important that ways of identifying and dealing with such concerns were found. These different attitudes towards a particular genetic modification can readily be exemplified by a specific proposal that came to the Committee in 1990.

A case study: the transgenic sheep, an ethical dilemma

In 1990 the ACNFP was asked whether animals from transgenic breeding programmes in which the attempted genetic modification was unsuccessful could be used as food. These sheep had been modified to carry the human gene for factor IX, a protein involved in blood clotting and needed for the treatment of haemophiliacs.

The gene was introduced by injection into the fertilised egg before reimplantation and rearing. Thus the introduced gene is present in all the cells of the animal, but is not active in all of them. And in this particular case, the clotting factor is released only into the animal's milk, from which it is readily purified. The process is, however, not very efficient. In many cases, the injected gene does not integrate and is degraded. In other cases, the gene is present, but is not expressed as a protein. So a large number of animals were reared to obtain one animal that produces factor IX in high yield.

The ACNFP was asked about the animals that contained no human gene – and therefore were absolutely normal, although they had been part of an experiment – and also the animals that contained an inactive gene or only part of a gene. Could they be eaten? The Committee could not think of any food

9 Adams, J. *Risk*, London: University College Press (1995).

safety reason why animals without any detectable foreign DNA should not be available as food.[10] However, in considering the wider issues the Committee thought that there might be ethical concerns about the food use of such animals. They wondered, for example, if consumers would object to eating an animal that had been part of a scientific experiment, or animals containing an inactive human gene. They debated whether this gene was just a stretch of DNA like any other, or something special, because it came from a human being. How would people react to eating an animal containing a human gene? Would they even regard it as akin to cannibalism? Would the newspapers run such headlines as 'Failures from genetic engineering experiments in your supermarket' if the Committee allowed these as food?

There were wider issues. The Committee did not know whether Muslims or Jews would be concerned about pork genes in lamb, or vegetarians about animal genes in plants, but decided that it was probably not just an issue of technical safety, and suggested to the Minister that there should be wider consultation. The Minster agreed, and a small ethics committee, of which I was a member, was set up, under the chairmanship of Rev. Dr John Polkinghorne, which consulted widely. That committee received submissions from many groups, and also talked to a number of them.

The Christians were divided. Some had no objections, but many had an uneasy concern, which they found difficult to articulate, a feeling shared by many non-Christians too, and which has been termed the 'yuk' factor. The Jewish reaction was more straightforward. After all, they have been dealing with subtle issues about food for many centuries. 'If it looks like a sheep, then it is a sheep' was their very pertinent comment. Muslims and Hindus were much more opposed, as were the animal welfare groups and also the vegetarians.

None of the groups consulted were moved when it was pointed out that there was effectively no chance of eating the original human gene, for it was hugely diluted in the processes of genetic manipulation, and the gene inserted into the sheep was more correctly called a 'copy-gene'. They were concerned even should the gene be completely synthetic. They were also concerned by the 'slippery slope' argument. These sheep had only one human gene in 30,000 sheep genes. But what if there had been a 50:50 mixture of sheep and human genes? Then I think all of us would have been concerned.

There was obviously quite widespread unease, and the ethics committee in its Report[11] made a series of recommendations – including the recommendation 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 trans-genes in food'. In the event, the Minister put such restrictions on the use

10 Advisory Committee on Novel Foods and Processes, *Annual Report* (1992), p.7. All ACNFP Annual Reports can be found on the Food Standards Agency website: www.food.gov.uk
11 *Report of the Committee on the Ethics of Genetic Modification and Food Use*, London: HMSO (1993).

of meat from such sheep as food that in practice not even the animals with no foreign genes could enter the food chain.

Where does this concern about eating animals which might contain fragments of a foreign gene spring from? I am sure that some of it comes from a deep antipathy to meddling with 'Nature'. This was well put by Prince Charles, who famously objected to '...taking into the realm of man what rightly belongs in the realm of God'. For him and for some others, genetic modification is seen as 'unnatural' and many of the concerns that face new technologies arise because people think they are 'unnatural'. There is in society a widespread romantic view of nature which sees everything 'natural' as good and anything tampered with by humans as bad.

But what do we mean by 'unnatural' or natural'?[12] [13] Perhaps the most basic meaning of the word 'natural' is captured in the titles 'Natural History' or 'Natural Philosophy', which describe the study of the world around us. Then there is another meaning of the word, and that is 'natural' as opposed to 'supernatural'. There is yet a third meaning and that is 'natural' as opposed to 'artificial' or 'deliberate', and that is the way in which it is being used in these debates. Indeed I suggest that the word 'natural' has become not a description of the world around us, but a value in itself. I also suggest that in our postmodern Western world, which has largely abandoned conventional religion, the 'natural' has become the 'Good'. This looks to me to be a form of pantheism, and I recall some wise words of John Stott's[14], arguing that we must avoid the deification of nature. This, he pointed out, is the mistake of the pantheist, who identifies the Creator with his creation, of the animist, who populates the natural world with spirits, and especially of the New Age Gaia movement which gives 'nature' its own self-perpetuating mechanism and leaves no room for God. It seems that for many people a concern about the natural world, and about the animal kingdom especially, now fills the gap occupied for most of human history by faith in God. Creation has taken over from Creator, and we are in danger, as a society, of worshipping 'Nature', whereas in contrast Christians worship the Creator of the natural.

This particular perspective on the 'natural' goes back to the beginnings of the Romantic Movement, in which the poets Coleridge and Wordsworth were so influential. They wrote in blank verse and other free forms; their objects were drawn not from the closed and ordered life of man in society, but from a limitless world in which all things were possible to the spirit and will of the individual. The literature was no longer judicial and objective; it was enthusiastic and expressive of the inner soul of the poet. The poets became aware of the life of the remote and primitive past; of simple persons, who were regarded

12 For a more detailed discussion see the Nuffield Council of Bioethics Report on *Genetically Modified Crops: the ethical and social issues*, pp. 13-15. www.nuffieldfoundation.org
13 For further reading see Trigg R. *Rationality and Science*, Oxford: Blackwell, 1999, pp. 80ff
14 Stott J. in the Foreword to 'The Care of Creation' R. J. Berry (ed), London: IVP, pp. 7-9 (2000).

with tender and pitiful emotion, and finally these poets began to discover in Nature an inexhaustible source of inspiration. The movement came to fruition only after the turbulence driven by the ideas and events of the French Revolution. From France came the notion that the central fact of existence was the individual, who was essentially good. The evils of life were due to the perversion of that natural virtue by pestilent social institutions; humanity was to be liberated and allowed to remake the world into a fit home for all. Using his or her own feelings as a guide, undreamed of happiness would result.

Surely Christians are not romantics in this sense: we do not have to assume that nature as we find it is ideal. But we do have responsibilities as stewards of this world, even though perfection is not going to be found here.[15] So as good stewards, how can we continue to care for this planet, and in particular how can we get ready in time to meet new threats? One answer is the use of the precautionary approach.

The Fourth Stage: The Use of the Precautionary Approach

It is sometimes suggested that new technologies, for example genetically modified foods or crops, should not be used because there may be a very low probability that some unpredictable and serious consequences for the consumer or the environment may ensue, and such risks should be eschewed. This case is frequently argued in terms of the so-called *precautionary principle*. The argument is that, irrespective of all possible benefits, a new technology should never be introduced unless there is a guarantee that no risk will arise. Since no one can ever guarantee an absolute absence of risk arising from the use of, for example, GM crops, it follows that there should be a delay in the use of the new technology until complete assurances of absence of risk are available. It is difficult to see how this happy state could ever be attained, and a rigid interpretation would probably mean that no new technologies would ever be introduced. Meanwhile the precautionary principle has become elevated by some almost to the status of the eleventh commandment.

An alternative interpretation of the precautionary principle is that we should 'proceed with care', when we have no well-grounded reason to think that the hazard will arise and when there is a valuable goal to be achieved. These two differing interpretations are often confused, and they lead of course to very different outcomes. For this reason I think that the term precautionary approach is the more appropriate,[16] and there are several reasons for suggesting this.

15 See for example, an interesting discussion in Clark S. R. L. *Biology & Christian Ethics, Cambridge:* Cambridge University Press (2000) especially pp. 94 -104.

16 For a more extended discussion see the recent Discussion Paper from the Nuffield Council on Bioethics *The Use of Genetically Modified Crops in Developing Countries* (2003) especially the Summary and Conclusions pp. 3-4, and para.4.48, p.62. (www.nuffieldfoundation.org).

First, an excessively conservative interpretation of the precautionary approach, demanding evidence of the absence of risk before allowing the pursuit of a new technology is fundamentally at odds with any practical strategy of developing new technologies. There are countless cases in the recent history of technology which indicate that a demand for the demonstration of the absence of risk would have made achievements impossible which in fact have become accepted by most people in developed countries, from the practice of vaccination to the use of mobile phones.

Secondly, it is easier to forego possible benefits in the light of assumed hazards, if the *status quo* is already largely satisfactory. This situation may vary from country to country, for example between developed countries, and developing countries where the state of poverty, agricultural practice and health, are often desperate. A recent report from the Nuffield Council on Bioethics[17] has argued that the potential for genetically modified crops to help subsistence farmers in the developing world is really so substantial that 'there is an ethical obligation to explore these potential benefits responsibly, in order to improve food security, profitable agriculture and the protection of the environment in developing countries'. However, it also points out that developing countries might well be reluctant to approve GM crop varieties for fear of jeopardising their current and future export markets to the EU and because they may not be able to provide the necessary infrastructure to enable compliance with the EU requirements for traceability and labelling. So what many see as the extremely conservative regulations in the EU are limiting the choices of developing countries, and may well disadvantage farmers who struggle desperately against poverty. With the biblical challenge to Christians to 'remember the poor'[18] before us, and remembering too what John said about helping our brother in need,[19] we surely have a responsibility to find ways to support their freedom of action. Is a very low theoretical risk to the European consumer more important than the famine conditions of many in the developing world?

As an example of the complexity of the issues raised by food aid, the situation in south-west Africa in 2002 is striking. In the autumn of that year, Zimbabwe and Mozambique agreed to accept milled GM maize from the US, but the Zambian government remained unconvinced and rejected 63,000 tons, despite the threat of more than 2 million Zambians facing starvation. That decision was based on appeal to the precautionary principle as well as on advice from a team of Zambian scientists who undertook a fact-finding mission to the US, Europe and South Africa. There were fears that unauthorised planting of GM maize could have unpredictable consequences in terms of gene flow, and in particular that pollen could eventually spread to fields on which non-GM maize might be grown for export so that future export markets might be lost. Although the governments of Zimbabwe and Mozambique eventually

17 Nuffild Council on Bioethics *op.cit.* [12]
18 Gal. 2:10.
19 1 Jn 3:17.

decided to accept milled food aid, the Zambian government was sceptical about whether GM food was safe to eat. While it was acknowledged that GM maize may be safe for consumption by the population in the U.S., where the crop forms a relatively small proportion of the diet, it was noted that maize accounted for as much as 90% of the typical Zambian diet. It was also feared that the high prevalence of AIDS in Zambia might have a deleterious effect on consumers of GM maize. It should also be noted that there is no evidence for either of these concerns.

This situation caused wide divisions. Many considered that, in view of the number of people faced with starvation in Zambia and the low and purely theoretical risk, it was safe to proceed. Others expressed support for the Zambian position and referred to the notification procedure enshrined in the Cartagena Protocol, arguing for respect for the decision to reject GM food aid. Others criticised the US policy of always donating food aid in kind rather than in cash and still others that the US did not offer to provide milled maize once it had become apparent that several African countries would prefer the donation in that form. Some saw this as evidence of pressure from the exporting countries while others were concerned that pressure had been put on developing countries from the opposite end of the spectrum, and it has been alleged that African leaders were advised by EU officials not to accept GM maize, although this has been firmly denied. There are also reports that European non-government organisations were active in persuading Zambian government officials to reject GM crops. In this complex mixture of science and politics, the issues seem to be political rather than scientific, and the Nuffield Council for Bioethics, in considering the issue, recommended that developing countries should be offered choice if possible, that they should be provided with full information about the crops and that if GM food is made available it should be provided in a milled form. However this is likely to be only an interim solution.[20]

Thirdly, to hold to the most conservative interpretation of the precautionary approach invokes the fallacy of thinking that the option of doing nothing is itself without risk. Yet food security and environmental conditions are deteriorating in many developing countries. This is not to say that we should be imprudent in the assessment of risks. It is to say, however, that restrictive interpretations of the precautionary approach, that imply a general prohibition on the use of GM technology, require very strong justification.

The Nuffield Report concludes that an adequate interpretation would require consideration of risks implied by the current *status quo* in relation to those posed by possible alternative paths of action. It is also worth noting a European Commission (EC) Communication, which recommends that measures based on the precautionary approach should, among other things, be pro-

20 For a more detailed discussion see the Nuffield Council of Bioethics Discussion Paper 'The Use of Genetically Modified Crops in Developing Countries' (2003) para.5.37-5.42. *www.nuffieldfoundation.org*

portional to the chosen level of protection, non-discriminatory in their application and consistent with similar measures already taken. Further, the measures should be based on an examination of the potential benefits and costs of action or lack of action (including, where appropriate and feasible, an economic cost/benefit analysis); they should be subject to review, in the light of new scientific data, and capable of assigning responsibility for producing the scientific evidence necessary for a more comprehensive risk assessment.[21]

So in summary, an excessively conservative interpretation of the precautionary approach, demanding evidence of the absence of all risk before allowing the development of any new technology, means very simply that we will never develop any new technology. Such an interpretation is essentially impractical. It is however much easier to accept possible hazards if there are clear benefits, although again it is often very difficult to predict the benefits of a new technology when it is still at an early stage. Who could have predicted the revolution brought about by the invention of the internet?

Another situation arises when the *status quo* is already unsatisfactory. I believe that it is a fallacy to think that the option of doing nothing is itself without risk. Indeed in some cases the use of the new technology may well bring fewer risks than use of the system already in operation. And it is clear that in the final analysis, value-judgments are involved.

A case study: Antibiotic resistance genes

Everyone knows the problems that have been caused in medicine by the emergence of bacteria resistant to antibiotics, to the extent that many antibiotics are no longer usable, and the search has had to go on for more. There is huge selection pressure for such resistant organisms to emerge and this is facilitated by the fact that many of the resistance genes are located on extrachromosomal microbial plasmids. Could such a problem arise from eating genetically modified foods either by cattle or humans? This was a real issue because such antibiotic resistance genes have been in widespread use as a selection tool in plant biotechnology, to select the very small proportion of host bacteria which have taken up foreign DNA. The question of a possible hazard from the spread of antibiotic resistance genes first became an issue in the consideration of a GM-maize variety produced by the company then called Ciba-Geigy. The ACNFP recommended against authorisation of this product for animal feed, its only proposed use. This was because of a perceived risk associated with the transfer of an antibiotic resistance marker gene in the maize, which had a bacterial promoter so that it would be expressed in bacteria, to bacteria living in the gut of livestock; and there was a theoretical possibility of transfer of the resistance gene to humans in contact with the cattle. The debate centred on the

21 Communication of the European Commission on the Precautionary Principle COM (2000) 1 Feb 2000, Summary p. 6. See also Section 6.3 of this communication.

question of whether antibiotic resistance was already so high in the general population that a very small increased risk would be of little or no significance, or whether the high level meant that no increase, however marginal, should be permitted. It was thus an issue of the significance, or otherwise, of an addition of a small risk to a large existing risk. The ACNFP took the more cautious view, influenced by the potential serious outcome of an event, which although very unlikely, was not impossible. This decision was confirmed by a poll conducted through the Newsletter of the International Society of Chemotherapy, that revealed that 57% of the members who responded opposed the use of this particular antibiotic marker gene, while a further 34% took the view that the risk of resistance-gene spread was low but finite.

The European Community, by a majority vote, later overruled this recommendation from the ACNFP, since the maize was only to be used for animal food. They took the view that the additional risk was so small that it was insignificant, clearly showing how in the final analysis, difficult judgments are involved. However, in Febuary 1998, Greenpeace applied to the French courts to overturn the issuing of the consent. The arguments still continue, and no seed has been sown. GM tomatoes on the other hand, contain a kanamycin-resistance gene in a form that did not cause concern to regulators, because the antibiotic had only very limited clinical use; but again there has been no commercial growing in Europe.[22]

This discussion illustrates vividly the difficulty that regulators face in making decisions that involve assessing very low levels of risk – and then in explaining them to the public. Is the risk of transfer of such antibiotic genes low, very low, or very, very low? It is ultimately a matter of judgment and all that regulators can do is to advise politicians as honestly as they can. So the well-burnished, almost old-fashioned virtues of judgment and integrity, so basic to New Testament teaching, come to the fore again.

The Fifth Stage: Societal Influences

Finally, we now have to recognise societal influences. The consumer is king, so we in the UK are in the process of opening up the risk assessment process, widening membership of committees, publishing agendas, publishing minutes, meeting in public, using much wider consultation about difficult issues, all to rebuild confidence in the outcome. The process is not proving easy to work effectively.

Although the ACNFP had developed its procedures continuously during my period as Chairman, those procedures were found inadequate to maintain pub-

22 For a more extended discussion see the Report of the Nuffield Council on Bioethics, *Genetically Modified Crops: the ethical and social issues* (1999) p. 32. (*www.nuffieldfoundation.org*), and Gasson M. & Burke D. 'Scientific perspectives on regulating the safety of genetically modified foods', *Nature Reviews Genetics* (2001) 2, pp. 217-222.

lic trust when the storm broke around GM soya. This was despite the presence on the Committee of a consumer representative, who effectively had the power of veto, and an ethical adviser. Consumer representatives are now becoming the norm on British Government committees, but were very unusual in 1990. The presence of an ethical adviser is still unique. The Committee had published its agenda, its findings and an Annual Report, with a Press Conference, for some years. But it was still accused of gross partiality: for anyone with an industrial link of any sort – a consultancy, or even funding for a research student – was judged to be biased. Yet if one rules out all those who have any connections with the applications of the science, how can those left be expert enough to be of any use? It is surely wiser to accept that everyone who is involved with regulation – environmental activists included – comes from a particular background that will affect their judgment. We do not yet know how we are to balance the role of the expert with that of the public.

But there are other issues, in particular the role of the multinationals that the agrifood industry has continued to consolidate. Some people and lobby groups are resisting GM foods and crops as a good way of resisting what they see as the continued insidious effects of globalisation. Similarly in the EU, the regulatory process has become becalmed because a number of the southern member states share this view.

All these issues are raised by GM foods, but I question whether they are intrinsic to the technology. Rather, I believe that GM foods have become a lightning rod for many modern concerns: scepticism about the trustworthiness of the regulatory process; gusts of anxiety about our food; growing hostility to high intensity agriculture; and concern about the way in which the agrifood business has consolidated into about six companies. In all these ways people show their concerns about the way the world is going. So decisions about the future of our food are being taken in the US or in Switzerland. Consumers feel that they have lost control and, not unnaturally, they blame the technology, and some wish to ban it altogether.

The UK government has tried to meet these concerns by continuing to increase the transparency and openness of the ACNFP, while leaving it otherwise largely unchanged. In addition, it has formed a new overarching committee called the Agriculture and Environment Biotechnology Commission with nineteen members from a very wide range of constituencies, from industry to green groups. The Commission met for the first time in July 2000, but it is still too soon to see how well it will work. Can the Chairman of Greenpeace UK, who is a member of the Commission, ever sign up to a position that has not been endorsed by Greenpeace? But politicians have put their trust in the successful working of this approach.[23]

23 Burke D., 'Transparency, accountability and inclusivity are not going to solve all our problems in handling risk' *European Review*, (2003)1(1), 91-98.

Changing attitudes to scientific evidence

Scientists like to believe that uncertainties in science are resolved primarily by the accumulation of ever-clearer evidence and that what we discover tells us something about what is 'out there'. However, others maintain that such resolution is achieved by a different process, that is, by a social process, by an 'agreement to agree about new things' and not by inexorable logic driven in turn by a set of crucial experiments. So the scientific process appears to them to be subjective and irrational, and they maintain that empirical evidence plays, at best, a subordinate role. This postmodern view maintains that scientific knowledge is 'socially constructed' and has no privileged claim to objective truth about the world we live in. The position embraces an explicit relativism in which observations of the natural world play only a limited role in obtaining scientific knowledge, at the same time rejecting the idea that a literary text has any intrinsic meaning, even that given it by the author, so that different readers will legitimately see different things in it. For this reason, no text can be regarded as intrinsically superior to any other: all is interpretation. According to postmodernism, there can be no overarching reason, no one true way of looking at things. On this view, postmodernism dethrones science by attacking that very human rationality that has produced science.[24] 'All truth is relative' is a common claim but it surely means little. 'What is true for me' becomes no more than 'what is believed by me', but not of course necessarily by you. So relativism may be true for you but not for me.

Coupled with this declining faith in the reliability of scientific evidence has come a greatly increased emphasis on an individual's 'right to choose'. In the consumer movement it has become a basic right, and whether the consumer's choice is seen by others to be rational or irrational is irrelevant; that choice must be respected. There is a similar attitude to scientific evidence: it is often maintained that people have the right to believe, or not to believe, a particular piece of scientific evidence, particularly if the evidence is disputed in any way. Whether to accept or reject religious faith also becomes a matter of purely personal inclination, for there is no absolute truth out there, and to assert that there is, either in science or in Christianity, is deemed to be 'judgmental'. In the extreme, evidence is weighed equally with opinion. After all, authorities are no longer trusted as they were, and sometimes with good reason; individuals do have rights, and we live in a democracy where every individual has equal standing. But does this mean that there is now no such thing as an authoritative statement? Can anyone, everyone, make up their own minds as to what is 'true'? Has opinion overtaken knowledge? Obviously at the extreme that way lies social chaos, so in current politics we have to find a compromise between evidence-driven policy and what is acceptable to an electorate, and electorates do of course have the final veto. But how should electorates inform themselves? That is the question. What sort of communication is needed?

24 For further reading see Trigg R. *Rationality and Science*, Oxford: Blackwell, 1999, pp. 64ff.

If scientific evidence is no longer the rock-hard indisputable set of ideas we once thought it was, how can we trust its findings? Does it matter for science? Certainly a recent House of Lords report called 'Science and Society'[25] thought so and said:

> Society's relationship with science is in a critical phase. Science today is exciting, and full of opportunities. Yet public confidence ... has been rocked by BSE and many people are uneasy about the rapid advance of areas such as biotechnology and IT (information technology)... This crisis of confidence is of great importance both to British society and to British science.

It also matters for our faith, for the same mindset slides easily over into our thinking about Christian faith and poses believers a particular problem, for Christianity is a historical religion: Christ has died, Christ has risen and Christ will come again.

Public attitudes to risk have become an important part of the debate over new hazards. There is public concern about the long-term health risks arising from industrial processes and products; about risks from accidental releases of chemicals; from the effects of exposure to chemicals at low dose levels and the effect of all these hazards on our children and our grandchildren. Similar attitudes show themselves over genetically modified foods and the release of genetically modified plants. These attitudes often puzzle those who have worked all their lives in the scientific laboratories. 'Don't they trust us?' is their question, and the answer is only a cautious 'Yes, but'. Trust in the safety of the products of new technologies has been eroded by the outbreak of BSE and its spread into the human population, by rows over the safety of the Mumps Measles Rubella vaccine, and by a whole series of food scares. Many of these food scares have been amplified by the media, but the public would not read the stories unless they were concerned about possible risks, and the newspapers might stop printing them. Scare stories do sell newspapers. People are worried about what is happening to their world, and they do not know whom to trust.

The distinguished moral philosopher Onora O'Neil pointed out in her 2002 Reith lectures[26] that the problem is not so much that of a loss of trust as of the creation of a climate of suspicion. She points out that people responding to opinion polls tend to say they trust no one, not doctors, not politicians, not lawyers, not estate agents, not research scientists – but they in fact place their trust in them perforce. Actions might be thought to speak louder than words. If we want to draw up a contract, we have to trust a solicitor. If we have appendicitis, there is nothing for it but to go to a surgeon. Society simply cannot function without our placing trust in such experts; good behaviour whether in the

25 *Science and Society*. A report from the House of Lords Select Committee on Science and Technology, HMSO (1999), p.5.
26 O'Neill, O. *A Question of Trust: The BBC Reith Lectures 2002*, Cambridge: Cambridge University Press. www.bbc.co.uk/radio4/reith2002/

city or on the streets depends on non-cynical trust. This is true in the churches too. Trust has often been eroded by the foolish, sometimes criminal actions of a small number of people carrying responsibility, often, sad to say, in the ordained ministry.

So what are we to say as Christians about the loss of trust – in science and scientists? Society cannot function without some trust; nor can the churches. But trust is easy to lose and very hard to regain and we are going to have to work very hard on this for years to come. To maintain that 'It will be alright on the night' is not going to be sufficient. Trust too is central to our own personal Christian faith: trust in God and trust in each other is a pillar of our faith. We who live in a cynical society have to demonstrate that trust is still reasonable and workable, and live lives of total integrity.[27]

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27 1 Tim 4: 11-12.