



Ethical arguments relevant to the use of GM crops

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The Nuffield Council on Bioethics (NCOB) has published two reports (1999 and 2004) on the social and ethical issues involved in the use of genetically modified crops. This presentation summarises their core ethical arguments. Five sets of ethical concerns have been raised about GM crops: potential harm to human health; potential damage to the environment; negative impact on traditional farming practice; excessive corporate dominance; and the ‘unnaturalness’ of the technology. The NCOB examined these claims in the light of the principle of general human welfare, the maintenance of human rights and the principle of justice. It concluded in relation to the issue of ‘unnaturalness’ that GM modification did not differ to such an extent from conventional breeding that it is in itself morally objectionable. In making an assessment of possible costs, benefits and risks, it was necessary to proceed on a case-by-case basis. However, the potential to bring about significant benefits in developing countries (improved nutrition, enhanced pest resistance, increased yields and new products) meant that there was an ethical obligation to explore these potential benefits responsibly, to contribute to the reduction of poverty, and improve food security and profitable agriculture in developing countries. NCOB held that these conclusions were consistent with any practical precautionary approach. In particular, in applying a precautionary approach the risks associated with the *status quo* need to be considered, as well as any risks inherent in the technology. These ethical requirements have implications for the governance of the technology, in particular mechanisms for enabling small-scale farmers to express their preferences for traits selected by plant breeders and mechanisms for the diffusion of risk-based evaluations.

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Introduction

The Nuffield Council on Bioethics is an independent body established by the Nuffield Foundation and co-funded by the Wellcome Trust and the UK's Medical Research Council. Its terms of reference are:

1. To identify and define ethical questions raised by recent advances in biological and medical research to respond to, and to anticipate, public concern;
2. To make arrangements for examining and reporting on such questions with a view to promoting public understanding and discussion; this may lead, where needed, to the formulation of new guidelines by the appropriate regulatory or other body;
3. In the light of the outcome of its work, to publish reports; and to make representations, as the Council may judge appropriately.

Within these terms of reference, the Council determines its own priorities and topics. In 1999 it published its first report on GM crops, *Genetically Modified Crops: the Ethical and Social Issues* [1]. In 2004 it published a follow-up report, *The Use of Genetically Modified Crops in Developing Countries* [2]. The present paper summarises the relevant arguments from those two reports, noting developments since 2004. Two main conclusions were asserted in both reports. Firstly, policy towards GM crops should rest on a case-by-case analysis, with no general presumption in favour or against. Instead of general assertion, what was required was a sober assessment of the benefits and risks of particular applications against the feasible alternatives. This principle carries several implications, including those related to administrative capacity in developing countries. The second main conclusion was that where there were grounds for a responsible use of GM crops, there was a moral imperative for making such crops readily and economically available to those in developing countries who wanted them. If benefits were available, it would be contrary to the principles of justice and solidarity for those benefits to be hoarded to the detriment of the poor.

In what follows I shall set out the considerations that led the Council to come to these conclusions. The main consideration leading to the view that there was a moral imperative to make modern plant technology available to those in developing countries was that poverty and food insecurity called for action and there was no reason to deny developing countries the benefits of a valuable technology. Obviously this argument depends on denying what some have asserted, namely that there are strong ethical or prudential reasons for resisting the introduction of GM crops. The principal arguments involved in these latter claims relate to naturalness, the risks associated with GM and the justice of property rights. All of the ethical issues have implications for governance.

The moral imperative

The potential benefits of GM crops will be well known to this audience, so I shall simply list the ones that the working party thought were most important. They included:

1. Herbicide tolerance, enabling reduced applications of herbicides.
2. Insect and pest resistance.
3. Bacterial, fungal and viral resistance.
4. Abiotic stress resistance.
5. Micronutrient enrichment.

How might these benefits be especially relevant to developing countries? The relevant argument runs as follows. In the developed world, food production has kept ahead of population growth during the past 60 years. This was also the case for much of Asia and Latin America where the benefits of the Green Revolution were felt. However, Africa and some parts of Asia saw little gain in agricultural productivity, and poverty persisted. Moreover, the initial rates of improvement of the Green Revolution were not sustained between 1985 and 1990. Even in countries like India, where there are ample stores of staple foods, poverty still causes problems of access for large numbers. Moreover, given that 70% of the world's poor live in rural areas and two-thirds of those rely upon agriculture, there is a strong case for focusing upon agricultural development, particularly as improvements in agricultural productivity contribute to the creation of employment, thus raising incomes.

The above argument can be succinctly summarised in Fig. 1. As can be seen, the central thrust of the argument related to the need to raise agricultural productivity as a way of improving food supply and increasing agricultural incomes. However, there are specific potential applications of GM technology, of which the most important is the provision of micronutrient enrichment, that were also an integral part of the working party's thinking.

The argument assumes that GM technology is beneficial and that there is a moral imperative to enable developing countries to take advantage of these technologies. Although not expressed in the same words, the message of both reports is consistent (I believe) with the Social Doctrine of the Catholic Church when it asserts that:

***'Modern biotechnologies have powerful social, economic and political impact locally, nationally and internationally. They need to be evaluated according to the ethical criteria that must always guide human activities and relations in the social, economic and political spheres. Above all the criteria of justice and solidarity must be taken into account.'* [3]**

There are several points to make about the argument developed by the Nuffield Council.

1. The argument assumes that there is a need to raise agricultural productivity to deal with the problems of poverty and food insecurity. It may be true that there are enough foodstuffs in the world such that if they were more equally distributed existing production levels would be sufficient to feed everyone. However, this would require a politics of redistribution on a global scale that would dwarf any politics of redistribution even in advanced welfare states. As the 2004 Report put it, '[g]iven the limits of redistribution, we consider that there is duty to explore the possible contributions which GM crops can make in relation to reducing world hunger, malnutrition, unemployment and poverty.'
2. It is *not* part of the argument that the only way in which the problems are to be addressed is by the use of technology in general or GM technology in particular. The important point is that a potentially valuable technology should not be ignored. The moral imperative relates to the circumstances in which the technology is valuable, but there is no assumption that GM is

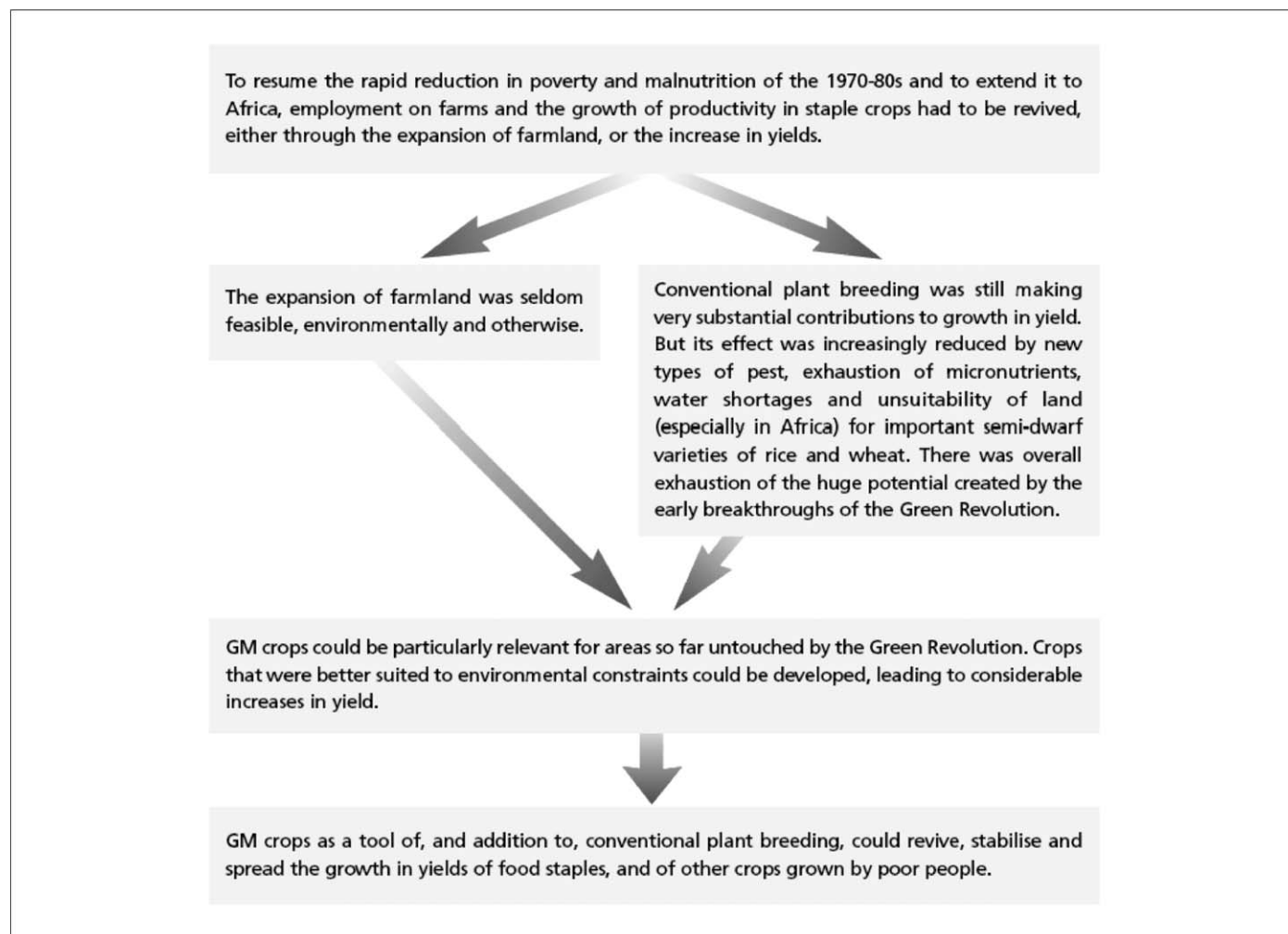


FIGURE 1

Summary of Nuffield Council Argument.

the only, always the best or most appropriate technology, and indeed one needs to accept that promised GM solutions may fail in particular cases.

3. Because the provision of agricultural technology will not on its own solve the problems of poverty and food security, attention needs to be given to administrative and regulatory capacity in developing countries as well as regimes of property rights, if the benefits are to be equitably shared.
4. The reports were written at times when the debate on GM was polarised. From Nuffield's point of view this is unfortunate, because it prevents a case-by-case approach in which the benefits and the risks of the technology are assessed in particular instances.

This then is a summary of the claim for there being a moral imperative to make the responsible use of GM technology available. However, as I have noted, this position involves denying the claims of some critics of the technology. So I now pass to an assessment of these crucial points of view.

Naturalness

One reaction to GM crops is that they are in some sense 'unnatural' and that it is wrong in itself to change the 'essence' of species or to interfere with the natural order. This is a widespread sentiment:

many of the respondents to the consultation on our first report for example thought that the breaches involved in genetic modification represented an improper tampering with nature. Such sentiments were probably reinforced in the case of UK citizens by the experience of BSE in cattle, in which the BSE agent was spread to cattle in meat and bone meal, leading many to think that the disease would not have arisen had herbivores not been fed meat.

However, although these sentiments are widespread, both of the working parties involved in the Nuffield reports found it hard to make sense of the claims involved, for the following reasons.

Any form of plant breeding can be regarded as unnatural. To be sure, if plant breeding simply relied upon the selection of individual plants from the variety of naturally occurring plants, then one might say that the practice was natural, in the sense that there was no human intervention beyond the mere selection of desirable specimens. However, since the discovery of Mendel's laws, plant breeding has become scientific, involving such practices as mutation breeding, in which plants and seeds are exposed to radiation or chemicals as with Calrose 76 or Golden Barley, or wide crosses as in the case of Triticale. The difficulty of distinguishing GM as 'unnatural' from conventional forms of plant breeding as 'natural' is enhanced by the fact that GM may be used as a technology to produce traits or characteristics in plants that could have been

produced by conventional plant breeding only more speedily or at less cost.

One form of GM plant breeding that to the layperson may seem unnatural is the introduction of genetic material from non-plant species, for example in the case of *Bt* crops where bacterial gene sequences have been used or the use of genetic material from salmon into strawberries. Clearly these sorts of transformations would not be possible without advanced techniques of genetic modification. However, the mixing of genetic material across very different species occurs in nature without human intervention, as in the mixing of genetic material from humans and animals in viruses.

One concern about the unnaturalness of GM techniques pertains not to their mode of production but to their possible effects, in particular cross-pollination with non-GM crops in the wild. However, this view can only make sense in a general form if non-GM crops are seen as the product of nature and GM crops seen as artificial, but that view ignores the fact that conventionally bred crops are unnatural by the same test as are GM crops. To hold otherwise is to hold that there is an unaltered realm of nature.

However, the concern about effects may be standing proxy for another reason, related to safety. It may be that the order of nature needs to be respected because biological and ecological systems are relatively robust and predictable, and so pose few risks for humans, who have after all evolved with those environments. Horizontal gene transfer does occur in nature, but over a long time scale, whereas with genetic modification the transfer of genetic material is sudden so that if GM plants are released into the environment, biological and ecological systems might not be sufficiently adapted to integrate the plants.

Of course, the introduction of any plant, however produced, can have untoward effects on the environment. The introduction of the rhododendron, which originated in Spain and Portugal, or of Japanese knotweed (*Fallopia japonica*) into the UK has resulted in a significant loss of biodiversity. However, it may be argued that the advantages of GM technology, in particular its speed and power, are precisely the features that should make one sceptical of its use. In other words, although it is hard to see what merit there is in the argument from naturalness, there might be an argument from safety.

Before turning to the arguments on safety, I note one further point about naturalness. The argument that it would be wrong to introduce GM crops because the technology results in what is 'unnatural' relies on the assumption that it is wrong to intervene in nature. If, as the Compendium on the Social Doctrine of the Catholic Church says, nature 'is a gift offered by the Creator to the human community, entrusted to the intelligence and moral responsibility of men and women' (Pontifical Council, §473), then there is no general reason to defer to the genetic stock of the natural order and no reason why nature cannot be improved.

GM and risk analysis

General points. The chief advantage of genetic modification in the breeding of plants is that changes can be introduced more quickly and directly, with a more precise targeting of the traits that is desired. Moreover, a wider range of traits than is possible with conventional breeding can be introduced. However, from the point of view of risk analysis, some of these features of GM look

as although they are problematic rather than advantageous. The speedy introduction of a wider range of traits may create untoward effects that are difficult to control. If rhododendrons or Japanese knotweed have had severe environmental effects in the UK, one might think that GM plants will pose a potentially greater threat to whichever environment they are introduced.

In this context, many urge the relevance of the precautionary principle. The precautionary principle has been formulated in very different ways both in law and in civic discourses. To evaluate the relevant arguments, therefore, we need to consider the strength of the claims contained in any precautionary approach.

Viewed in a moderate way, there is nothing exceptional about the precautionary principle at all. It is simply the principle that is followed in all cases of good design or good husbandry. For example, furniture is designed to carry much more weight than will ever be placed upon it, and buildings are designed to withstand shocks. Usually precautionary design of this sort leads to an increase in the cost of the product over a cheaper but less safe alternative, but the protection of human health and life from unnecessary risks is an obvious duty. Interpreted as such, the precautionary principle would not raise special considerations in relation to the development of GM crops. The technology would simply be subject to the usual safety assessments that any comparable technology would be subject to.

However, in recent years, the precautionary principle has sometimes been given some very stringent interpretations, and some of these interpretations have been taken to imply that there should be a moratorium or possibly even outright ban on GM technology. In its strongest form, a precautionary principle would place the complete burden of proof upon someone introducing a new technology to show that it did no harm. In this strong form it would be impossible to satisfy, and indeed it would place scientists and those developing potentially beneficial technologies in a situation that challenged their integrity, because no responsible scientist can promise no risk of harm whatsoever. As the 2004 Nuffield report put it 'an excessively conservative interpretation, demanding evidence of the absence of risk before allowing the pursuit of a new technology is fundamentally at odds with any practical strategy of investigating new technologies' ([2], p. 57). More generally, such a stringent approach would make the mistake of regulating on the technology rather than the traits produced by that technology.

With this general point in mind, we need to consider risk assessment both in relation to the environment and in relation to human health.

Environmental risk assessment. One particular risk that has concerned some people in connection with the planting of GM is that of gene flow from the modified plant to wild plants, particularly in areas of sensitive biodiversity. Gene flow occurs in nature of course, and is responsible for the wide variety of plants that have evolved. That gene flow occurred in the case of GM maize and native Mexican maize landraces in Oaxaca has not been disputed. The question has been over the threat of that gene flow to genetic diversity. There are many factors that help determine the effects of gene flow, but in the view of the Nuffield Council the existence of gene flow does not provide an argument for prohibiting the use of GM although it does suggest that in sensitive areas of biodiversity, GM crops ought not to be used without monitoring and that the

establishment of comprehensive seed banks to conserve genetic resources of crop plants and their relatives is of crucial importance.

More generally, it would be part of a precautionary approach to develop GM crops first in the laboratory and then in field trials before going to large-scale production, but this sequence is the one that is good practice in plant breeding in any case.

One potentially significant problem arising from an extreme interpretation of the precautionary principle is the potential for environmental regulation to become a disguised form of economic protectionism. Thus, if the stringent EU regulations on GM foods make it impossible for farmers in developing countries to export to the EU, this could be a serious problem.

Health risk analysis. In principle, some evidence of harmful health effects would provide a reason for being cautious about the introduction of GM crops, but such purported evidence as has been offered has not withstood scrutiny.

Against the lack of evidence relating to health risks, the 2004 working party was impressed by the potential of GM technology to enhance micronutrients, and took as one of its case studies the production of Golden Rice. At the time at which the report was being written there was no firm evidence about the bioavailability of β -carotene, but this is now available and would suggest that the moral priority is no less urgent.

There is an important general point about the precautionary principle in this context. The precautionary principle was initially developed in the Federal Republic of Germany before being taken up and developed in the European Union and international agreements. The context in which the early developments took place was in relation to pollution control, where much of the argument turned on the question of whether it was worth paying extra for clean-up costs given the lack of complete scientific evidence about the link between the pollution and the damage being caused. In other words it was a principle of action rather than inaction.

In relation to technological innovation, the precautionary principle is usually interpreted in a conservative way, and is thought to imply a disposition to hold back the introduction of the technology until further evidence comes to light. However, this conservative interpretation only makes sense in the context of a status quo that is satisfactory, such that no damage is done to human values by delay. This is not the case where there is known damage being done to human health and there is good reason to believe that some benefit can be achieved. In this respect, the precautionary principle ought to be an injunction to action rather than inaction.

Justice and solidarity

One reason why the Council returned to the topic of GM crops in its 2004 report was that at the time a renewed heated debate took place in the EU about the use of GM crops which largely ignored the global perspective. In most Western countries, agriculture is a highly efficient process, with a range of means of improving yields through fertilisers and controlling pest and abiotic stressors through pesticides and other means. GM crops improve this system in some cases. But many members of the public remain unconvinced about the technology, especially in view of only marginal improvements. Independently of the justification of these concerns, major issues around justice and solidarity arise from the fact that highly restrictive policies at the EU level affect

not only EU citizens, but also small-scale farmers in developing countries. For example, the Food and Feed and Traceability and Labelling regulations may perhaps seem like appropriate and feasible policy instruments for the governance of GM crops in the EU – but the segregation of GM from non-GM crops will generally not be feasible in developing countries. This has implications for the use of GM crops not only for export purposes, but also for domestic purposes. For even non-GM exports may be “contaminated” by GM crops used for domestic purposes.

For many commentators, justice issues are also raised by the role of industry in the production and marketing of GM crops. It seems plausible to assume that the GM story would have unfolded in a very different way if the first GM crop had been a GM food crop developed by the public sector (as opposed to ‘cash crops’ developed by industry). One key element in the public debate about GM crops is therefore the danger arising from monopolistic or oligopolistic control of the technology. The concern is that large private seed producers will put themselves in a position where they are able to exploit small farmers to the disadvantage of the latter. The 2004 report noted that five main companies (Syngenta, Bayer CropScience, Monsanto, DuPont and Dow AgroSciences) control most of the resources that are needed to undertake commercial research in the area of GM crops. There are large questions about the responsible use of property rights and the administrative capacity to implement adequate biosafety procedures. The Green Revolution was largely funded publicly, and rested on a property rights regime in which it was assumed that the fruits of scientific research should be freely available for all. Current plant breeding is now taking place in a different world, in which much of the lead is by private companies or by universities anxious to take advantage of patent protection. There is an interesting contrast here with other developments in science where ‘open source’ principles operate, whether in respect of Wellcome funding for the Human Genome Project or some branches of synthetic biology. However, the Nuffield Council does note that there are several specific issues that constantly need addressing both by those involved in the development of research and by the relevant public authorities:

1. Owners of patented technology should be encouraged to license their technology non-exclusively. There are examples where this has applied, but it is a constant area of concern.
2. Material transfer agreements are implicated in the development of GM crops, and where these include such provision as reach through rights, they may inhibit development.
3. Patent offices should be discouraged from granting overly broad patents.
4. The impact of patents on access to germplasm should be monitored.

One criticism of GM technology that is often made by critics is that it poses a threat to informal or traditional seed systems. However, when it considered this matter, the 2004 working party did not think that contemporary plant breeding practice was likely to be such a threat for the obvious reason that no form of high technology plant breeding prevents farmers from retaining and re-sowing their own seed varieties or landraces if that is what they choose to do. Conversely, if new or improved seeds are preferred by farmers, then it is entirely their own concern, provided that

environmental responsibilities are not at issue. The working party noted that farmers were aware that saved seed for open-pollinated crops like maize produced lower yields than F1 hybrids. So, farmers in Zambia, Kenya and South Africa have been buying hybrid seed from local or multinational companies for many years. For self-pollinated crops, there is nothing to prevent farmers from retaining seed from the harvest for many years.

Further evidence on this point comes from the use of *Bt* cotton in China, where the working party noted that, although seed costs were more than four times higher than the non-*Bt* varieties, the overall net revenues from the *Bt* variety were greater because of savings in pesticides and fertilisers. In short, the development of GM crops will confront resource-poor farmers with a wider range of commercial options, but it would be a mistake to focus merely on one element of their costs.

A particular problem might be thought to arise in the use of GURT (Genetic Use Restriction Technologies). One difficulty here is that such technologies have been developed to deal with the objection that GM crops pose an environmental threat, and so there is a trade-off of values that need to be taken into account. There is no obvious easy solution to this problem except insofar as the technology develops we learn more about the environmental risks that may or may not be associated with particular GM crop varieties.

It is worth noting in passing that one factor leading to oligopoly in commercial seed production is strong regulatory requirements, because it is larger companies that have the capacity to manage the obligations in relation to those requirements.

Conclusion

Since 2004, when the second Nuffield report was published, there have been several developments that are worth noting in conclusion:

1. The number of farmers in developing countries using GM crops has more than doubled and there has been a threefold increase in acreage, with the most common crops being soybean, maize and cotton. This is evidence that farmers are finding it advantageous to take advantage of the technology. The moral imperative is to ensure that they are in a position both to have access to the technology and to make a choice about its use in the light of their own circumstances.
2. Not all developments noted in the report have been successful, the most important example being the development of virus-resistant sweet potato in east Africa. This is an illustration of why the case-by-case analysis advocated by Nuffield is important.
3. Concerns about climate change are focusing attention on abiotic resistant crops, where issues about patent rights are likely to be important. Similar concerns are likely to lead to an interest in second-generation biofuels, where the potential of conventional and GM plant breeding looks significant.

It is not the task of an ethical analysis to be the champion for a particular technology. Instead such an analysis leads to laying down the criteria by which any particular technology can be assessed. Above all, we should avoid the fallacy of thinking that an ethical assessment will indicate a brake on technological development, particularly in cases where the technology addresses urgent human needs.

References

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