

GM crops: science, politics and communication

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As the public debate in Europe about genetically modified (GM) crops heats up and the trade row between the United States and the European Union over GM food escalates, what better time to examine the issues with an international group of experts (BOX 1). Their views are diverse, but they all agree that we need more impartial communication, less propaganda and an effective regulatory regime that is based on a careful case-by-case consideration of GM technology. It seems that GM crops are here to stay, so let us hope that these requirements are met and that the developing nations that perhaps have the most to gain from this technology can start to reap its benefits.

What are the best arguments that you have heard (or made) for and against GM crops?

- Positioning GM crops as ‘good or bad’ is a failure to recognize that each product of plant biotechnology is a discrete technology package that must be discussed on its individual merit. As an example, insect-resistant cotton has drastically reduced pesticide use and resulted in corresponding increases in beneficial insect populations. This GM crop has benefited farmers, consumers and the environment. I would refocus the question on current and emerging constraints on food and fibre production, and other issues of human health that would benefit by new technology. We must focus rationally on which technological approach is most effective, including GM. After rigorous scientific analysis indicates which approaches are viable, if the best choice is a GM product then we should balance risk versus reward and make a decision as we would with any other technology-driven life improvement.

C.J.A.

- Poor subsistence farmers whose crops are destroyed year after year by the ravages of nature have the most to gain by far. The toolbox that we call genetic engineering could

provide the most obvious short cuts to varieties of rice, cassava, sorghum and other staples that survive drought, flooding, pests and poor soil conditions. Traditional breeding and organic farming methods could and should be used alongside GM to transform African and Asian agriculture, provided that rich governments stump up the money so that publicly funded institutes can do the research that is suited to each country’s needs. In the corpulent cafe societies of Europe, with their glut of good food, GM stands no chance of being accepted until there is an obvious benefit for consumers, but it is a crime for indifference and hostility to block the development of GM by and for the world’s poorest. On the negative side, the most foolhardy application of GM would be to make all of the crops in a rotation resistant to the same weedkiller, which is something that farmers might be tempted to try if GM weedkiller-resistant wheat becomes available.

A. C.

- I find all arguments for and against GM crops (in the generic sense) completely pointless. As Richard Dawkins recently explained so lucidly, it is as pointless as constructing arguments for and against ‘substances’, because each transformed crop has unique characteristics in terms of food safety, and environmental and agronomic impacts. I am interested in informed debate about the safety and impacts of a particular crop, but unimpressed, if not bored, by the relentless propaganda on GM crops that is trotted out by both sides.

B. J.

- GM crops extend the techniques that are available to plant breeders to modify the genetic makeup of our main food crops so that we can reliably produce good yields with minimal damage to the environment. GM technologies should also enable us to modify the biological software of our crop species so that they are optimized for human and animal nutritional requirements.

To feed an ever-increasing world population in the next 30–40 years, if we do not want to destroy our remaining forests, we will need to produce double the amount of food from the same amount of arable land. GM crops are important because they offer the opportunity to increase the efficiency of food production with less damage to the existing cropping lands. GM techniques will enable us to protect crops from pathogen and pest challenges and allow them to cope better with abiotic challenges such as adverse weather conditions.

Box 1 | Contributors*

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Michael Rodemeyer is the Executive Director of the *Pew Initiative on Food and Biotechnology* — a non-profit making charity-funded organization that is based in Washington D.C., United States — which is committed to encouraging informed debate on agricultural biotechnology.

*Listed in alphabetical order.

Conventional plant-breeding technologies will continue to progress, but there are limits to what can be done by the current methods. In some cases, further capacities will need to be added to the crop plants. Of course, all GM modifications to crops must be fully tested before they are released, on a case-by-case basis, for any perceived hazards both to the environment and to human and animal health. **J.P.**

“In the corpulent cafe societies of Europe ... GM stands no chance of being accepted until there is an obvious benefit for consumers.”

• Farmers like the way that pest-resistant and herbicide-tolerant traits make it easier for them to grow corn, cotton and soybeans — which explains the rapid adoption of GM versions of these crops in the United States. There also seems to be broad agreement that *Bt* cotton varieties have reduced the use of chemical pesticides, but there is less agreement on the net environmental impacts of other GM crops. In the future, biotechnology has the potential to deliver consumer benefits and develop hardier varieties of crops that are more relevant to the needs of Third-World farmers — but economic, political and technical challenges remain. The need to manage unwanted gene flow, for both environmental and economic reasons, imposes uncertain costs on farmers, processors, distributors and others in the food chain. In a global marketplace, the rejection of GM crops by consumers in some nations, for good or bad reasons, raises particular production and trade challenges, and uncertainties about how the costs will be met. **M.R.**

There are large regional differences in public attitudes to GM crops across the globe: to what extent is this a result of the way in which the science of GM has been communicated and/or reported, and what are the best ways to improve public understanding of the issues involved?

• Messages sent by the media determine the public understanding of technology. When molecular biology was in its formative years in the late 1970s and the 1980s, we got off to a good start with the public in the United

States. Top scientists organized a widely publicized debate about genetic engineering and expressed their concerns about possible negative consequences of DNA manipulation. Their concern led to the creation of the Recombinant DNA Advisory Committee (RAC) in the federal government to do risk/benefit analyses and to halt or change projects if the risks are indeterminate or are considered too great to be reasonable. The RAC answered media questions during the time period in which a federal regulatory process controlling the use of genetic manipulation in research and industry was developed. The United States still garners benefit from these scientist-led public forums on biotechnology and our public has largely accepted new GM products from recombinant insulin to insect-resistant corn. However, as only a small percentage of the public is engaged in agricultural production, the need for new technology in this arena is poorly understood in comparison with health-care products. Therefore, public discussion of GM plant technology must continue and must receive unbiased media coverage. **C.J.A.**

• It all comes down to need and trust. Europeans oppose GM technology for four major reasons. First, traditional food is so abundant and varied that GM food cannot offer anything earth-shatteringly new and persuasive. Second, bovine spongiform encephalopathy (BSE) made them paranoid about the effects of even the tiniest material alterations to their food. Third, they did not like having GM food thrust on them through failure to segregate or label. Finally, they tend to trust the hype from non-governmental organizations over and above what anyone else says, because they seem to have ‘no vested interest’. I suspect that if ‘green’ groups issued a joint press release tomorrow saying that GM crops do not harm humans or the environment, the suspicions of the public would vanish overnight. Elsewhere, it is clear from the GM famine-aid debacle last year that African countries fear a European backlash against their exports if they embrace GM crops. So, there is a lot of sanctimonious, value-laden ‘imperialism’ dictating what is happening out there. Essentially, there is a chain reaction hinging on European consumer acceptance. If Europeans warmed to GM food, supermarkets would start to sell it and farmers could start to supply it. Then Africa would be happier experimenting with GM. If Europeans lose their fear of GM technology, opponents will lose the key economic weapon that enables them to continue obstructing it worldwide. They will

also lose a key ‘techno-hostage’ that is priceless as a bargaining chip in their wider battles against global capitalism. **A.C.**

• This really comes down to the low levels of public knowledge about agriculture in general, and specifically about the role of crop varieties in determining how our food is grown. I am not surprised that there is a degree of public panic associated with new crops. Consumers in Europe are rightly wary of novelty in agriculture and unwilling to take risks with their food and environment, and therefore ask serious questions about the need for these new crops. In the United States, most people have little interest in how their food is produced and trust the ‘authorities’ to fix anything that might go wrong.

Improving public knowledge means working with the media and public bodies over a sustained period, using evidence-based material, not rhetorical hype. Unfortunately, agriculture, crop breeding and biosafety are not the ‘sexiest’ subjects for the media, and most people see genetics as a ‘difficult’ area to understand. **B.J.**

• In the United States, GM crops have been well accepted by most of the population, largely owing to the positive statements that were issued by both the previous President and Vice President. Also, most ordinary citizens have great faith in the **United States Food and Drug Administration (FDA)** and are prepared to accept the safety of new foods and farming practices if the FDA, or a similar regulatory body, approves them.

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GM crops have been less well accepted in Europe for many reasons. One was the rather insensitive way in which the first material was sent to Europe from the United States. GM and non-GM derived materials were mixed together without any real preparation of the citizens of the countries. We had the extraordinary situation of a GM tomato paste being sold in supermarkets in the United Kingdom, proving to be a success and then being withdrawn because the supermarket proprietors

were unwilling to risk consumer reaction to what had become a contentious issue. There are other reasons in many countries and yet, although various anti-GM groups were extraordinarily well organized, active and created a lot of media attention, in some countries such as Switzerland the majority of citizens voted in favour of GM research and its eventual use in the food chain. **J. P.**

• Polls indicate that American consumers are not well informed about GM foods and remain largely unaware that they are already eating foods with ingredients from GM crops. Although United States consumer concerns about the safety of GM food do not drastically differ from those of European consumers, there is little evidence in the United States of the intensity of concern that is seen in Europe and other nations. This difference might in large part be owing to the trust that is placed in the United States Food and Drug Administration. Without the equivalent of the 'mad cow disease' debacle to raise food safety concerns and doubts about the credibility of government regulators, American consumers are simply more complacent. The United States media has been far more balanced in its coverage of GM food issues than some of the European tabloids, but the actual experience of a disastrous food crisis has probably had far more impact on public attitudes than the different modes of media coverage. Restoring trust and credibility in science and government will require open dialogue, transparency and time. But, unless biotechnology delivers some perceived value to consumers, changing attitudes will be a slow process. **M. R.**

What are the key issues that need to be addressed in formulating an effective regulatory framework for GM crops and is it possible to achieve some degree of global consensus on their regulation?

• Technology development and product introduction are regulated by individual countries rather than globally, and GM crops are unlikely to be an exception. The regulatory focus needs to be directed towards the properties of the end product in comparison with its non-GM alternative, because each new crop will be unique. As a new generation of GM plants is developed to deliver plant-made pharmaceuticals, they might fall under stricter regulatory standards if the products are to enter international distribution. Commercial considerations will dictate if new products must meet regulatory standards worldwide in order to be competitive. As regulations

continue to develop in this arena, 'global consensus' can only be approached if the emphasis remains focused on the transparency of process coupled with clear and timely communication to the public about benefits and concerns. **C. J. A.**

• It would be helpful to have some global consensus on how to regulate GM crops, perhaps in the hands of an independent United Nations approvals and policing body that accommodates the interests and concerns of rich and poor, and of environmentalists as well as backers of the technology. On consumer choice, I think it is easier to voluntarily label material that is guaranteed to have been produced without GM. This would enable it to be sold at a premium to consumers who want to avoid GM absolutely, whereas consumers who are less fussy accept that by default there might be GM-derived material in their food. On farm 'contamination', I think we have gone over the top on regulation thanks to the availability of super-sensitive analytical technology. Common sense tells me that contamination only matters if it materially alters the quality or safety of the harvest or of a processed food. Organic standards are artificial constructs that are designed to reflect a philosophical value system, but some might question whether the ideology is being carried to ridiculous extremes as an excuse to exclude GM farming. I will let others debate that. Consumer demands are paramount, however, so in the end I accept, on those grounds alone, that European authorities made the right decision to introduce draconian labelling, traceability and crop-separation legislation. **A. C.**

• We know what an effective regulatory framework looks like, because we have just that in the United Kingdom. The key issue is institutional capacity building, especially in the developing world, to ensure that high regulatory standards are applied everywhere. That is a serious challenge for organizations such as the Food and Agriculture Organization of the United Nations (FAO) and the Consultative Group on International Agricultural Research (CGIAR) to address. We can learn a lot about regulatory effectiveness from failures in the regulation of pesticides. The foundation stones for the global regulation of transgenic crops have already been laid, but there is much work to be done. **B. J.**

• Each proposal for a GM crop needs to be assessed on a case-by-case basis. It is important to thoroughly examine any perceived hazards for human health, which would often

mean checking on whether or not there are any indications of toxic or allergenic substances introduced by the GM modification. As most modifications will make a relatively minor change to the quality traits of the grain, root or leaf, and the food that is made from those products, the compositional analysis of the GM crop needs to be compared with the standard crop so that a decision about substantial equivalence is justifiable.

Then there are questions about the performance of the GM crop in the field. Mostly this will concern the nature of the breeding system. If it is an inbred crop, then there might be no concerns about the spread of either pollen or seed from the agricultural environment. If it is an outbred crop and there are weeds or native plants that are able to be crossed with the crop species, then there needs to be a full assessment of the likelihood of that happening and of the subsequent possibilities of any undesirable spread. The idea that a 'super weed' could develop through the acquisition of herbicide-tolerance genes from GM crops has often been talked about. However, in reality this is unlikely to occur, even with the outcrossing of crops such as canola, because of the low frequency of crop-to-wild gene flow and the lack of selection pressures encouraging transgene acquisition.

“Polls indicate that American consumers are ... largely unaware that they are already eating foods with ingredients from GM crops.”

There must be a thorough check on the nature of the new genetic segment that is introduced. In the first GM crops, selection genes such as those for antibiotic resistance were used. This is no longer necessary and the gene of interest can now be introduced without any other genetic material being present. It is still necessary for the regulatory body to establish that there has been a full description of the transformation event, and also that studies have been carried out to show that there are no unexpected properties in the GM crop as a consequence of the site of insertion of the new genetic material. **J. P.**

• A regulatory framework needs to be effective — that is, it needs to actually protect public health and the environment — but it also needs to be credible. The credibility of a

regulatory system is particularly crucial to the acceptance of new technologies if consumers cannot directly judge for themselves the safety or environmental effects of the product, but need to rely on expert judgements. Any regulatory system needs a good set of tools, sound science and adequate resources, but it also needs transparency and public oversight to establish its credibility. Today, global consensus is elusive in part because the United States and European regulatory systems clash on the ways to achieve these regulatory goals. Although the differences between the two approaches are often overblown, the European Union approach leans heavily on transparency and consumer choice as a means to rebuild confidence in a regulatory system the credibility of which has been severely damaged. The United States faces no comparable task. Coming to a global consensus on GM crop regulation will require a more open discussion on the goals of a biotechnology regulatory system than has so far occurred, or that is likely to occur in the midst of current GM crop trade disputes.

M. R.

“...many of the arguments that are used against GM crops are really arguments against the misuse of power by the large multinational companies...”

What are the key challenges that face scientific and commercial advocates of GM crops?

• There is an increasing barrier for new crops to enter the commercial pipeline and, therefore, to benefit consumers. Although my colleagues and I have made significant progress with GM plants that are designed to produce oral vaccines, the transition from research to development is difficult. Escalating regulatory costs for moving into the scale-up of prototype materials are daunting, especially as much of the focus of our effort is on vaccines for the developing world, such as those for the diarrhoeal diseases that are major killers of the very young. Unfortunately, the limited commercial potential of public-health products does not attract private investment. Financing public-health products is even more difficult while the public acceptance of new products from GM crops remains an issue in some parts of the world. To return to your question, in this regard, the challenges to both

the scientific and commercial advocates of GM crops are doggedly coupled. I am troubled that emotional judgements of GM technology will create barriers to the realization of plant-based solutions to the public-health problems that are of enormous importance to the poor.

C. J. A.

• They have made a real hash of it so far. It is no good telling consumers that they are being unreasonable and expecting them to mellow if they understand more about the technology. The secret is to give them the bald truth, warts and all, and to trust them to make informed decisions based on what is good for them individually. It is difficult now that most Europeans have gone beyond the ‘tipping point’ of rationality. GM is now a term of abuse and has become for many people — because it is such an easy target — an automatic symbol of the folly of science and the inequity of capitalism. But two recent reports made a good stab at even handedness: the [United Kingdom government report on the economics of GM crops](#) and the [United Kingdom government report on the science of GM crops](#). Both reports were scrupulously fair, setting out with admirable frankness the grim prospects for acceptance in Europe in the face of such messianic and psychologically entrenched opposition. Their big selling point was their brutal honesty, balancing the positive with the negative in the same document and admitting huge areas of scientific uncertainty.

A. C.

• Quite simply, to show that the crops that they are producing give net benefits to consumers and farmers, and are as safe as conventionally bred crops. European consumers are still not convinced that the benefits from herbicide-tolerant and insect-resistant crops outweigh the risks, especially the environmental risks. The present generation of GM crops gives only marginal benefits, and the risks (however small) are perceived as not worth taking. It is likely that either commerce or public research institutes will soon produce transgenic crops that give outstanding benefits, such as pest resistance, disease resistance and better nutritional qualities, which are demonstrably safe.

B. J.

• As a scientist, I have found that when I have given talks about GM crops, especially about how and why they are produced, the audience has been very receptive. People are interested in having more information about the technology and in gaining a better understanding of just exactly what the whole GM business is about.

But, in large public forums and debates, I think there is sometimes a feeling that scientists that are speaking in favour of GM crops are just pushing their own interests and biases, at least that is the way the media often present it and, of course, it is the way that the opponents of GM crops speak about those of us who are involved in this science.

I think that the commercial advocates of GM crops face an even bigger barrier because many of the arguments that are used against GM crops are really arguments against the misuse of power by the large multinational companies that often advocate them.

J. P.

• Biotechnology companies need to accept that they are in the food business as well as in the seed business — and in the food business, the customer is always right. Scientific reports might help assuage safety concerns, but in the end, consumers (especially in Europe) need a reason to overcome their reluctance to buy GM foods. So far, the biotechnology companies simply have not provided a good enough reason. As long as consumers can exercise a choice, they will avoid even a small perceived risk if there is no benefit. Beyond consumer acceptance, advocates of biotechnology face political and social challenges. GM crops have become a ‘drive-by’ casualty in the broader battles about globalization, American hegemony, economic concentration and the increasing dependence of agriculture on technology. Biotechnology advocates, as well as the United States government, need to develop far more effective strategies to respond to those arguments than they have deployed so far.

M. R.

“GM crops are here to stay — the timing of their adoption will be determined by the economic and societal impact of each product.”

GM crops in 20-years’ time: ubiquitous or unheard of?

• GM crops are here to stay — the timing of their adoption will be determined by the economic and societal impact of each product. I doubt that GM crops will be ubiquitous though, as traditional genetics is also moving rapidly and will lead to continued improvement in crop performance, as it has for the

last 60 years. What I do see, however, is a significant increase in the use of plants for the production of industrial raw materials and new pharmaceuticals; in this arena, DNA technology will be invaluable for changing processing traits or product composition. As an example, when a cost-effective cancer drug is derived from a transgenic plant, I do not anticipate adverse public reaction to the means by which it was manufactured. The public will be no more aware that plants might be used to create the cancer drug than they are today that chicken eggs were used to manufacture flu vaccine. **C. J. A.**

• Personally, I do not care whether GM crops are accepted or not, but if some varieties are rejected, I would like to see it happen because of incontrovertible evidence that there are genuine health or environmental problems, not because of open-ended hypothetical doomsday scenarios that can be spun out for all eternity. So far, the health and environmental problems that they pose seem to be non-existent or minor. But problems could emerge in new generations of crops, and political and ideological opposition to GM will ensure that it remains marginalized in Europe. It would take a brave French farmer to grow a GM crop. Outside 'fortress Europe', GM will indeed be ubiquitous, especially when China takes over from the United States as the economic powerhouse of the world, closely shadowed by India. Whether it will be helping African farmers to defeat the elements I do not know, but I will be angry if they are not even given the chance or the money to try. In the final analysis, the best chance for acceptance is the realization by the public that they do not get the full story either from the industry itself, from government, from non-governmental organizations or from the media, who all have a vested interest in cherry picking the 'facts' to suit their own objectives, values and agendas. Information from all parties is tainted and 'spun'. Take global warming for example. George Bush rejects the consensus on that, but happily horsewhips Europe on its refusal to accept the (broadly) consensus view that GM technology is safe. The complete reverse is true of environmentalists, who reject the *status quo* on GM but merrily accept the consensus on global warming. Scientists simply become pawns in much bigger political and ideological games, irrespective of the merit of their work. I have lots of time for organic farming and conventional breeding, and think that both have great potential in their own right. But I think that it is madness to abandon GM for what are essentially political, economic and ideological

prejudices. It is unfortunate that the GM 'child' is judged to have come from a 'bad family'. Hopefully, people will begin to accept that GM is simply a 'toolbox' of technologies that are as broad in their application as something like electricity, or even that icon of invention, the wheel. They will not solve all problems, but might tackle some, hopefully alongside conventional and organic options. And, like wheels or electrical devices, there will be good and bad applications, so each needs to be judged on its own merits. **A. C.**

"The public will be no more aware that plants might be used to create the cancer drug than they are today that chicken eggs were used to manufacture flu vaccine."

• My guess is that transgenic crops could be widely used in 20-years' time, but only if they contribute to more sustainable methods of agriculture. Globally, agriculture is already in crisis because of soil degradation, drought and crop diseases that threaten the sustainability of production, the human population increase and increased meat consumption. In 20-years' time, we will need to use every resource we have if we are to continue to produce enough food with lower environmental impacts. It is possible that research in the new crop-breeding facilities in developing countries will produce the new plants that are needed for small-plot farmers to produce food with low inputs and more reliable production. At the same time, the developed world will need to adopt more sustainable agricultural methods if they want to continue to produce high volumes of commodity crops. Transgenic plants will probably be used to fulfil some of the needs of both types of agriculture, but there will also be many other new varieties produced by 'conventional' breeding using newly acquired genomic knowledge. **B. J.**

• I have no hesitation in saying that GM crops will be accepted right across global-trading communities in 20-years' time. Right now, they already have a significant role in agriculture. The 53 million hectares of GM crops are all finding markets and are being grown and used in both developed and developing countries. In Australia, there has been an acceptance of GM cotton: there seems to be no concern about fibre from a GM crop,

whereas there is plenty of discussion about the food crops. But, as GM crops are produced with quality traits that are of benefit to the consumer in preventive health, then I am certain that our societies will realize that these food products are just as safe, if not safer, than any other food products.

Initially, commercial interests argued against labelling, probably because of cost factors in production systems, packaging and so on. But, in my view, labelling that gives a clear idea of both the composition and the mode of the production of food is necessary to ensure that consumers retain their freedom of choice. **J. P.**

• Genetic engineering is here to stay — the technology is simply too powerful to put back on the shelf. But how that technology will be deployed in the next 20 years is more difficult to predict. Some biotechnology advocates believe that the technology is so irresistible to farmers that it will simply become ubiquitous and that consumer doubts will eventually dry up in the absence of any clear health or environmental problems. Others are more sceptical. In the short term, consumer acceptance issues will continue to make it a hard road for introducing whole foods and grains that are directly consumed as food — such as rice, wheat, fruit and vegetables — particularly without a clear consumer benefit above conventionally bred varieties. However, GM cotton is flourishing not only in the United States, but also in China and Egypt, which points to a brighter future for non-food uses of GM crops. In the longer term, as the technology matures and disperses, and as other nations begin to develop their own varieties that deliver value to their farmers and citizens, GM crops will lose their globalization stigma and become more widely accepted around the world. **M. R.**

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Online links

FURTHER INFORMATION

CGIAR: <http://www.cgiar.org>

Charles J. Arntzen:

<http://lsvl.la.asu.edu/plantbiology/faculty/arntzen.htm>

CSIRO: <http://www.csiro.au>

English Nature: <http://www.english-nature.org.uk>

FAO: <http://www.fao.org>

Jim Peacock: <http://www.csiro.au/index.asp?type=resu&id=PeacockJim&stylesheet=aboutCSIROResume>

Michael Rodemeyer:

<http://pewagbiotech.org/about/staff/rodemeyer.php3>

New Scientist: <http://www.newscientist.com>

Pew Initiative on food and biotechnology:

<http://pewagbiotech.org>

The BSE enquiry: <http://www.bse.org.uk>

United Kingdom government report on the economics of

GM crops: <http://www.number-10.gov.uk/su/gm/index.htm>

United Kingdom government report on the science of GM

crops: <http://www.gmsciencedebate.org.uk/report/default.htm>

United States Food and Drug Administration:

<http://www.fda.gov>

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