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GM foods
The wrong debate?

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FOOD ETHICS COUNCIL

From the editor

GM foods: the wrong debate

Tom MacMillan

GM is back, prompting election debates in Australia, royal foreboding in Britain, and argument over aubergines in India.

Higher food prices have given the technology's champions fresh confidence to challenge European opposition to GM foods. They accuse us of holding the world back from tackling food insecurity, and they warn that this selfishness will reverberate in our own backyard, because insisting on scarce and expensive GM-free animal feed pushes EU farmers and consumers to the wall.

And British politicians, at least, seem on their way to being convinced of the force of those arguments.

But for all the welcome focus on Europe's international responsibilities, calls for more debate over the technology are a depressing throwback to the height of the GM controversy in the late 1990s.

We should have learned – from the previous decade of wrangling over GM foods – that to have meaningful debate about innovation we need to ask not 'Do we need GM?', rather 'What do we need?'

It all comes down to logic. Ask whether we need any specific new technology – a crop, computer or medicine – and the honest answer is that we don't. We can't be sure it would do what we want and there could always be another way – new technology is uncertain by nature.

Ask whether it could help and the answer is that it could, however outlandish the example, for just the same reason. Because the question determines the answer, it can't help anyone decide anything. Calling for debate about a technology is just nice way of telling people to like or loathe it, depending how you ask.

So yes, let's have a fresh debate about innovation in agriculture. But we must ensure that it is open and wide-ranging, not a narrow, dead-end discussion about one set of technologies. To devote our attention to GM, whether through accident or opportunism, is to ignore tough lessons from a decade of controversy.

This edition of Food Ethics lays the foundations for such an open debate. We have built on themes from our four past reports about GM foods and innovation – 'Novel Foods', 'Engineering Nutrition', 'TRIPS with Everything?' and 'Just Knowledge?' – to create a blueprint for a debate that moves us forward rather than sinking us into the stagnant arguments of the past ten years.

In the first section, our contributors take stock of a decade of research and deliberation around GM foods. Peter Lund describes how the science has moved apace – the plummeting cost of gene sequencing means that we can answer some technical questions that seemed impossibly uncertain a short while ago. Our understanding of the genome has changed too: the fact that the same gene sequence can be involved in generating thousands of different proteins, depending what else is going on in a cell, throws a googly at the notion that genes are the 'book of life'.

> **We need to ask not 'Do we need GM?' rather 'What do we need?'**

If we are interested in needs, values and responsibilities, however, science is far from enough. Over the same period, we have seen research and institutional innovation to ensure that needs and values play a bigger part in policy and regulation.

For example, grappling with GM foods in a climate of fragile consumer trust has forced European risk regulators to revise some of the cruder concepts that had underpinned technology assessment. As Adrian Ely argues, there is still some way to go before decision-makers are fully-equipped to make sense of the social issues that inevitably inform their judgement, and which should do so clearly and accountably.

Yet ten years' work has provided us with an impressive armoury of approaches to draw upon, including an influential EU project called Safe Foods and, unusually, a lead from Codex Alimentarius.

GM has modified the way we do democracy too - both in the UK and in some other countries. At least it did briefly, Tom Wakeford tells us. But now, disappointingly, we're backtracking on the progress we'd made. On choice and trust we hear of similar lessons that are at risk of being ignored. Power in the food chain has changed too, says David Hughes, with further consolidation in the seed sector.

So what does it mean to take these lessons seriously? One implication is that we concentrate more on solving problems and less on arguing over technology.

That sounds easy but the consequences are profound. Our scientific institutions, regulatory bodies, innovation policies and intellectual property regimes are a long stretch from being fit for effective problem-solving. Far from being a carte blanche for GM foods, it means putting them on hold pending deep-rooted institutional reform.

To show what's at stake, four contributors explain how they'd solve some of the key problems GM foods are claimed to address. Whether the challenge is beating hidden hunger or boosting the economy, good governance is paramount. This is a key message from the International Assessment for Agricultural Knowledge, Science and Technology for Development (IAASTD), which reported in April, and it deserves to be heard.

A handful of scientists and governments jumped ship from IAASTD when the report made unimpressed noises about GM foods. That misses the point: above all, the report represents a growing consensus on what agricultural innovation for the public good should look like. Whether or not you think GM foods will be the outcome is irrelevant. It is time for a pact – let's agree the process and live with the consequences. ■

The science

We have more answers but not enough

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A referenced version of this article is available at www.foodethicscouncil.org

The front cover of the science journal 'Nature' on 24th April shows two rows of papaya, one genetically modified (GM) to resist papaya ringspot virus, the other not. The non-resistant variety bears a few solitary fruit and appears ravaged by the virus, whereas the GM plants are far healthier, with large clusters of fruit on each plant.

GM varieties now account for over half the commercial papaya planting on Hawaii, and pictures of this type are part of the stock-in-trade of the agbiotech industry. The big news reported in Nature was the complete sequence of the genome of the transgenic papaya - the first of any commercial GM crop - and the paper reporting this sequence concludes that this "should … serve to lower regulatory barriers currently in place in some countries".

Robin McKie, writing enthusiastically in the Observer, says "as Nature's cover shows, the technology seems ripe to help feed a planet whose population will rise from 6.5 billion people, many of them already hungry, to around 9 billion by 2040". But a quick trawl of the web reveals many concerns about this apparent success story - reports of contamination of non-GM plants, questions about the evolution of viruses which may become able to grow on the GM variety, and issues about losses of market share for exporters.

Anyone familiar with the GM debate of the last few years, and the controversies surrounding it, will be tempted to shrug their shoulders and ask what is new. Then, as now, examples of what appeared to be dramatic successes in the development of novel crops were followed by counter-arguments about loss of yield, risks of gene flow to non-transgenic varieties, the effects on the economics of farming, and the short-term nature of GM solutions. So as the potential of GM to help address the growing food problems in the world is revived as a political talking point what, if anything, has changed in recent years, as the GM debate has partly receded into the background?

The indisputable success of technical progress in describing what a GM crop actually is at the genetic level can translate into misplaced over-enthusiasm for the technology as a whole

From a scientific perspective, the most dramatic change is unquestionably the growth in the ability of scientists to analyse the different species concerned at the genetic level. The Nature paper reporting the complete DNA sequence of GM papaya is only one of numerous papers to come tumbling out of laboratories around the world as the costs of sequencing fall and the rates of data generation improve. On the day of writing (14th July) the GOLD (genomes online) database reports nearly 4,000 genome projects, some complete, some in progress.

Costs have fallen from millions to thousands of dollars per genome, and the time taken to determine a whole genome sequence from years to weeks or even days. Sequencing a whole plant genome is still a serious undertaking, but well within reach of a competent scientific consortium.

On the back of this technical revolution comes a host of other methods which enable scientists to gather large scale data about organisms in ways that were barely thought of ten years ago. One of these is metabolomics: the ability to identify and measure most of the different small chemical constituents (metabolites) present in a given species, tissue, or crop. Another is proteomics, which does the same thing for all detectable proteins.

This at least has allowed one of the controversies about GM to be addressed: that of 'substantial equivalence'. This term was initially introduced as a regulatory definition, not a scientific one, and given the high degree of variability in the composition of non-GM crops, it is a notoriously hard concept to pin down with any rigour. However, published data comparing GM and non-GM varieties of potato shows that using the most precise technical and analytical tools currently available for metabolic and proteomic analysis, the only statistically significant differences seen between them are those anticipated from the particular genetic modification made: unintended consequences of the genetic manipulation are not seen. Whether this is generally true for all GM crops can only be judged on a case-by-case basis, but at least the methods are now available to do such assessments.

However, the indisputable success of technical progress in describing what a GM crop actually is at the genetic level can translate into misplaced over-enthusiasm for the technology as a whole: the high-powered microscope of molecular biology is not the best tool to assess the performance of GM crops in

the field, or to pursue concerns about safety to human health or the environment. What indicators are there that would enable us to judge whether the world-wide GM experiment is a success story, a dismal failure, or somewhere in between?

In terms of adoption by farmers, GM appears to be ahead in the argument. The most recent USDA report shows that GM soybeans in the USA make up 90% of the crop, and cotton and corn varieties engineered to be resistant to herbicides or to insect attack all make up greater than 50% of the USA's acreage. The world-wide acreage of cultivated GM crops has increased at least 50 fold since 1995, and although the USA leads the charge, many countries are close behind, notably China, India, and Brazil. In the USA at least, this increased adoption is driven by the farmers' expectations of improved yields or, at least, greater profits. Are these being realised?

A report from the Soil Association suggested not, although several of the papers and reports cited in this study are quoted selectively or out of context, and do indeed provide what appears to be robust evidence of increased yields or higher profits, at least in the short term. One thing that has not changed in the GM debate, however, is the difficulty in obtaining reliable data from an unbiased source, and given the enormous complexity of the issues involved, it is probably still too early to state whether GM crops represent, overall, a net long term economic benefit for farmers who plant them.

Environmental issues have always been a key component of the GM debate, with one focus being the issue of gene flow from GM to non-GM crops. It is now accepted that measurable gene flow between closely related species occurs at a low level all the time and is not something which is new to GM. The apparent discovery in 2001 of GM material in landraces of maize in Mexico has not been supported by subsequent studies, but such gene flow can indisputably occur and a small number of cases have been reported where a transgene has been found in a near relative, presumably due to adventitious cross-pollination.

Increased adoption is driven by the farmers' expectations of increased yields or, at least, greater profits

Whether or not the novel gene will become established in the plant over the long term (through the process known technically as introgression) remains unclear, but the potential is certainly there.

Recent studies under controlled field conditions have shown that transgenes can persist through several generations when transferred into weedy relatives, even in the absence of selection, although this causes reduced fertility in the plant. A clear consequence of introgression of a herbicide resistance gene would be that weeds related to the crop would not be controllable by use of the herbicide.

There are potential methods available to prevent or minimise the unwanted spread of genes from GM plants to their near relatives, collectively known as GURTs (or genetic use restriction technologies). Many of these are unpopular as they are seen as giving undue power to seed retailers, an example being the infamous 'terminator' technology, which renders plants unable to produce seed. These technologies often illustrate the point, made over and

We have more answers but not enough

over again in the GM debate, that it is not the ingenuity or even the utility of a technology that drives its use and ultimately its acceptance, but its place and potential impact in the complex network of biological, economic, and social interactions that make up agriculture in the broadest sense.

What of the health concerns about GM food? The Pusztai affair served as both a catalyst and focal point for much of the controversy about GM food and, several years on, it is perhaps surprising there have still been few feeding trials reported in the scientific literature. In part, this may be because scientists can see little point for doing such studies and publishing them, given that nearly all published data show no effects of a GM diet, and given also the high level of compositional equivalence between GM foods and their immediate biological parents referred to above.

Regulatory bodies such as the Advisory Committee on Novel Foods and Processes see the results of large numbers of animal studies, which in my experience have never reported any significant ill effects, but these are generally neither peer-reviewed by independent professional toxicologists nor published in the scientific literature; moreover, they are often conducted by the very companies who are applying for permission to market the foods that they are testing.

A series of claims about major negative effects of GM soya on rat health have been made by Russian scientist Irina Yermakova, which have received some press and internet attention, but her data is yet to be subjected to any kind of peer review, and concerns have been expressed about how her studies were done.

It is not the ingenuity or even the utility of a technology that drives its use and ultimately its acceptance

Overall, little work has been done over the last few years looking at the effects on animal health of GM food consumption, and in the work that has been done and properly reviewed, effects are generally not seen. An exception is a series of studies undertaken in Italy and Mexico on the effects of GM soya on mice, which do show evidence of subtle histological differences in some tissues of animals fed on diets which contain either GM or non-GM soy. These studies are interesting and it is to be hoped that they will repeated and extended, but it is not yet clear whether the variations seen are more significant than those which would be seen between animals fed on differing non-GM diets.

Where does this leave us? A problem in the GM debate is that while it often becomes polarised around particular issues which are amenable to quantitative testing, it is driven by deeper ideals and beliefs which are not. Thus although in the main the scientific evidence on the health effects and environmental impacts of GM foods gives rise to no obvious concerns, it fails to address the intuitive dislike of these foods which is expressed by many people.

This dislike may result from socio-political concerns that are raised by GM around (for example) ownership, intellectual property, corporatism, and the appropriateness of technological solutions to what are often human problems. It may arise simply from a feeling of intrinsic wrongness about the crossing of species barriers that GM food unquestionably entails.

The legitimacy of adoption of GM in the UK and Europe should certainly not depend solely on the scientific criteria - though these perhaps need to inform the future debate more than they have done in the past - but also on a host of wider human and social questions that science cannot address. At this most important level, the debate remains as complex, and as unresolved, as ever. ■

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Genetics

DNA is dynamic

The future of GM foods has hinged on principles as well as practicalities. The chief objection is that mixing genes from different organisms is wrong. But that rests on an out-dated grasp of genetics: Watson and Crick might have cracked the code, but the code wasn't all it was cracked up to be.

The simplest such objections to mixing genes are theological: God made distinct kinds of organism and it is sacrilegious to mess about with His creations. There is probably little arguing with such a dogmatic stand. But many religious people nowadays, even if they believe in divine creation, accept that evolution was the method God used for His constructive ends, so more than this simple objection is needed. The 'Yuk!' factor evoked by GM is often not grounded in theology at all but in misconceptions of biology. In particular, I suspect it is a view of the genome as the essence of the organism, the blueprint which already contains implicit within its sequence structure the fine details of the adult organism, that leads to the belief that there is something fundamentally problematic about genomic intervention. The idea that the genome has a qualitatively different status from other molecules in the cell is sometimes called 'genetic exceptionalism'. Assumptions about genomes underlying this exceptionalism are increasingly hard to defend.

First, the picture of the genome as a blueprint that requires from the rest of the cell only the machinery for decoding the finished product is hopeless. Genomes have resources that can be deployed in many ways by different organisms. The same stretch of gene sequence can, by virtue of subsequent reorganisation of gene products, end up involved in the generation of thousands of different protein products. So even at the level of protein products, whether the cell generates a certain product depends on much more than merely the sequence of nucleotides. In fact it now appears that even the experience of the organism can affect the functioning of the genome and, thereby, chemical processes in the cell. A well-studied example is the sequence of effects by which maternal care of rats leads to changes in the chemical activity of brain cells which, in turn, generate maternal behaviour in the adult pups. This illustrates the complexity of the processes by which features of an organism are transmitted to future generations and the dependence of these processes on a great deal more than merely the genome.

Against genetic exceptionalist objections to GM it is often pointed out that, whatever the ethical status of intentional manipulation of genomes may be, it has being going on for millennia through selective breeding, and through natural selection for thousands of millions of years. This is unquestionably true, but is apparently easily rebutted. Selective breeding certainly leads to changed genomes, but the changes that occur are all confined within the bounds of a species or, at least, a closely related group of species. This is quite different from putting bits of a snowdrop in a strawberry, or a bacterium in a potato? This violation of the integrity of the species genome is arguably 'unnatural'.

As a matter of fact, however, it is much less unnatural than is widely recognised. Microbes are now known to exchange genetic material regularly, often with very distantly related organisms. Even among higher animals, and certainly among plants, hybridisation is far commoner than was once thought, though this does involve fairly closely related organisms. Perhaps more significant still, all animals and plants, far from being isolated systems with species-specific genomes are actually complex symbiotic systems. Some 90% of the cells that make up a functioning human are bacteria essential to the proper functioning of the whole, and these bacteria contain about 99% of the genes within the symbiotic whole. There is almost certainly some gene exchange between the diverse components of this system. And perhaps most significant of all, for every cellular organism on earth there are about 10 virus particles. Viruses are nuclease vectors, carrying RNA or DNA into cells and in many cases inserting DNA into genomes. Cells are often able to excise this alien DNA, but in many cases it stays within the host genome. It is increasingly believed that insertions of DNA have played a central role in major transitions in the trajectory of evolution of multicellular organisms. So the insertion of foreign DNA is hardly a uniquely human innovation; indeed life exists in a constant and massive flux of DNA against which individual genomes are only partially insulated.

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It seems possible that a better sense of the dynamic nature of the genome and its constant changes in response to internal processes, external influences, and virus-borne DNA, might make us more sanguine about the minor human contributions to this process. We are right to be cautious about changes to the nature of the things we eat, but this caution calls for evidence about consequences rather than treating as sacrosanct particular parts of biological systems. These abstract discussions of principle have profound practical outcomes. With starvation a very real risk to human well-being in much of the world, we have an ethical duty to consider very seriously ways that food security might be significantly enhanced. The debate over the usefulness of GM foods must go on - genetics cannot rule that debate off-limits on principle. ■

Risk

Safety is just the start if we want good regulation

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Transgenic crops are being put forward as a solution to the food crisis. The controversies that dogged their introduction, at least in Europe, are being dismissed as dangerous distractions. Difficult lessons about risk regulation, learned over decades of debate, are in danger of being swept aside in the hope of a quick technological fix. Instead of backtracking on advances in European regulation, which have made it increasingly sensitive to scientific uncertainty and social issues, the answer lies in taking them further.

European Food safety regulation was in flux before the GM controversy. A series of food-related scares had stripped away public trust. When research published by Pusztai (transgenic potatoes), Losey *et al* (monarch butterflies) and Quist and Chapela (gene flow in Mexico) called one official assurance about GM crops into question after another, it seemed like the BSE scandal all over again. However, people weren't just concerned about these scientific risks: research at the time showed that they were concerned with broader social and political questions such as who would control and benefit from the new technology and who would carry the risks. [1]

The first response to this catalogue of problems from the EU and many member states was to introduce a new division of labour between government departments responsible for promoting the food industry and those in charge of making sure it was safe. Within the latter came a stricter separation of the 'independent' scientific analysis (risk assessment) function from the value-laden process of political decision making (risk management). However, in practice, it has proved impossible to completely separate the institutions and functions of risk assessment and management. Improving their respective contributions to decision-making is important, but it is also necessary to ensure that the interface between them is organised in an efficient, open and transparent manner. This has led to the recognition of 'risk assessment policy' [2] through which social framing assumptions shape various aspects of risk assessment, and increased attention to divergent values associated with the outputs of risk assessment.

Over the past decade, the ways that the risks of transgenic crops are governed in Europe have evolved considerably in other ways. A wider range of scientific criteria are taken into account and assessment has been opened up to broader considerations. Although some of these changes meant extra burdens for regulators and businesses applying to have GM food, feed or crops approved, they allow more rigorous assessments of potential adverse effects and a more democratically accountable debate (at least within the borders of the EU).

In particular, regulators have begun to look beyond the products themselves to consider the management regimes and social contexts in which they would be used. For example, the principle of 'substantial equivalence', which waived detailed toxicological and analytical studies when transgenic products seemed similar to their conventional counterparts, has been demoted to 'the first step' in a more rigorous process of safety assessment. In the environmental arena the UK farm-scale evaluations, which analysed species differences in fields of conventional and GM herbicide tolerant crops, examined the changes in cultivation practices allowed by GM crops. There is growing consideration of indirect, cumulative effects, and applications for cultivation of GM crops in the EU must now be accompanied by a monitoring plan to identify problems that had not been considered prior to release. [3]

A framework

An EU-funded research project that I've recently been involved with, called Safe Foods, tries to build on such changes[4]. Based on interviews with stakeholders, legal analysis and a series of workshops, our part of the project aimed to develop guidelines for regulators based on a broader notion of 'risk', allowing them to respond not only to risk proper (strictly defined, situations where probabilities and magnitudes of potential outcomes can be quantified) but also to uncertainty (when probabilities are unclear or disputed) and socio-political ambiguity (when the values or the significance of technical or social consequences are in question)[5].

A simplified version of the regulatory framework we suggest is shown in Figure 1. In effect, it formally distinguishes between processes that already go in regulation - framing, assessment, evaluation and management - so that each can be made more robust and transparent.

Conventional risk assessment is still appropriate for most food safety threats, when enough data exist to quantify confidently the probabilities and magnitudes of potential adverse effects and where socio-political concerns are absent. Sometimes, though, additional forms of assessment are needed:

precautionary assessment to deal more thoroughly with uncertain threats and concern assessment for socio-politically ambiguous threats.

By having a clear framing stage that specifies the most appropriate forms of assessment in the terms of reference to assessors, we can ensure adequate attention is given to the most salient characteristics of a food safety threat, while at the same time guarding against overly burdensome assessments.

Evaluation gathers the outputs from assessment and allows different stakeholders to deliberate on how tolerable any threats might be. These value-based considerations feed into management, where decisions are made about how to address the issues arising, and those are implemented and monitored by regulators, businesses and civil society. [6]

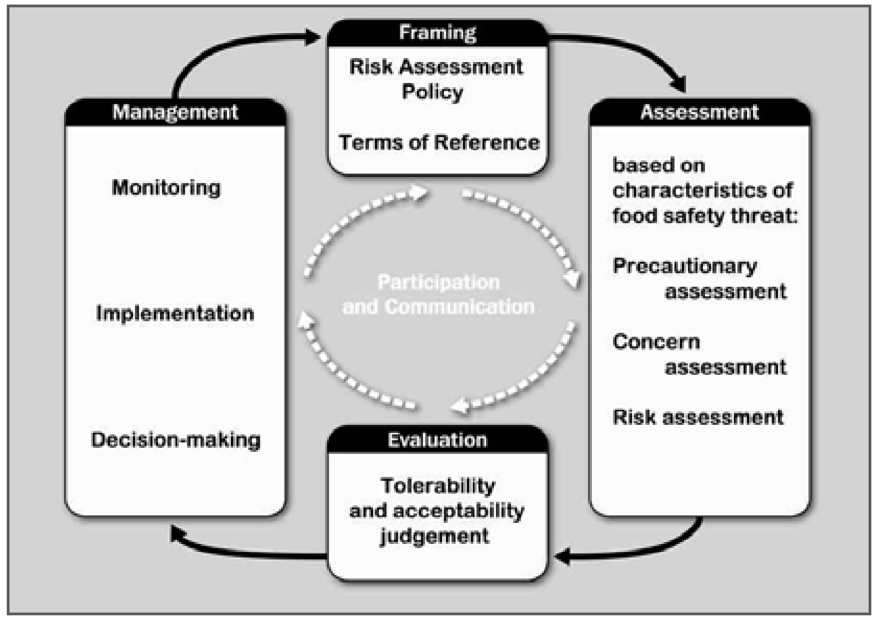

Figure 1. Primary stages in the risk governance framework adopted by Work Package 5 of the Safe Foods project

In Europe, the European Food Safety Authority is responsible for assessment and DG SANCO for management, but our research suggests that the stages of both framing and evaluation require the input of assessors and managers. They also demand wider involvement. The framework provides a structure for engaging stakeholders and members of the public. This is an accepted tenet of good governance in European policy, not least down to the bitter experience of failures to engage well over GM. This wider participation has a different purpose at each stage:

- Framing: to open up risk assessment policy and add legitimacy to the setting of terms of reference.
- Assessment: to broaden the sources of knowledge and information gathered.
- Evaluation: to deliver more legitimate value-based judgements on tolerability or acceptability.
- Management: to select the most appropriate measures and to aid implementation and monitoring.

High levels of scientific uncertainty or socio-political ambiguity require extended participation during assessment, evaluation and management. Of course, one lesson from GM foods is that even that may not be enough: the framework here deals with 'end-of-pipe' product regulation, yet the controversy also revealed a need to transform institutions responsible for agricultural innovation.[7] Along with the attention paid to socio-political ambiguity during concern assessment, that opens up broader questions beyond food safety and nutrition, for example over food security and food sovereignty (peoples' freedom to define and choose their own forms of food provision)

Where next?

At the start of the current French presidency of the European Union, an announcement was made that a "group of friends of the presidency" would be convened in order to consider the remaining problems in the EU system for regulating GM crops. This is an opportunity for Europe to consider the potential role of different forms of agricultural biotechnology globally, rather than just in its own back yard. Any resulting regime should recognise the specificities of the European context, and try to accommodate the concerns of other parts of the world that face radically different challenges and priorities.

Outside Europe, very different approaches to regulating the risks from GMOs have been adopted, with perhaps the most fundamental differences associated with labelling. Labelling GM products, central to food sovereignty concerns, began in Europe in 1998, as retailers sought to preserve consumer trust in their own brands.[8] EU legislation later standardised requirements across different firms and Member States.[9] Europe is still grappling with the co-existence challenges that this legislation raises. Labelling has not become compulsory in the USA, and other countries such as Japan have less stringent thresholds than the EU's 0.9% for adventitious presence. Elsewhere, for example in China, researchers have suggested that GM labelling is not yet a contentious issue and that GM, when commercialised, is likely to receive limited resistance from consumers.[10]

Questions of labelling, traceability and coexistence are probably most significant when considering the introduction of out-crossing transgenic food crop species to developing countries where seed saving and exchange is common. In some such countries strict labellingpolicies are less likely to be meaningfully implemented, and the limited scope for representative, informed concern assessment and evaluation also make the Europe-focussed recommendations outlined above more challenging to put into practice. As a major importer of food products from around the world, Europe has a responsibility to consider these complexities in any emerging governance regime for GMOs.

As well as potential adverse effects (or 'risks' in the broadest sense), Europe needs to take into account, transparently, the possible relative benefits of GMOs. Those need to be compared not only against other products, but also with alternative processes or practices that achieve the same ends. This presents a crucial challenge when considering some GM traits such as

Safety is just the start if we want good regulation

drought-tolerance in staple varieties which might, if they proved effective in practice, bring benefits for the economy and public health in some developing countries. As with risks, uncertainty over these possible benefits, and socio-political ambiguity (for example around their distribution) are vitally important.

Yet none of this comes from having less regulation of GM foods in Europe, or by trying to prune assessment back until it is once again confined to narrow technicalities.

By building in public participation, an alertness to uncertainty and greater space for assessing the social implications of new technology, Europe will be increasingly well-equipped to make sound decisions that build food safety, food security and food sovereignty. ■

[1] Marris, C. (2000) EMBO reports 2: 545-548.

[2] Millstone, E., P. et al. (2008) 'Risk-assessment policies', Joint Research Centre.

[3] EC (2001) Directive 2001/18/EC, OJ (17.4.2001): L 106/1.

[4] This article draws significantly on work conducted by Work Package 5 of the Safe Foods project (www.safefoods.nl) - Ortwin Renn, Marion Dreyer, Adrian Ely, Andy Stirling, Ellen Vos and Frank Wendler. The research will soon be published in Dreyer, M. and Renn, O. (Eds.) (2008) 'Food Safety Governance: Integrating Science, Precaution and Public Involvement', Springer.

[5] Stirling, A. (2007) EMBO Reports 8: 309-315.

[6] These steps in the management process are akin to those put forward by the International Risk Governance Council - see IRGC White Paper No1 "Risk Governance - Towards an Integrative Approach", IRGC, Geneva, 2005.

[7] Levidow, L. and Marris, C. (2001) Science and Public Policy 28: 345-360.

[8] Levidow, L. and Bijman, J. (2002) Food Policy 27(1): 31-45.

[9] EC (1998) Council Regulation 1139/98, OJ L159 (3 June), 4.

[10] Huang, J. et al. (2006) Appetite 46: 144-151.

Risk amplification

When consumers think about the risks involved with food products, they will usually make judgements that either amplify or attenuate those risks, effectively rejecting or accepting them.

Amplification factors include: involuntary consumption; a novel, man-made food product characteristic with unknown but probably long-term effects; a danger to vulnerable groups; and contradictory statements by scientists.

In contrast, attenuating factors present the opposite picture: a voluntary risk over which the consumer has control and can avoid; a natural source with well-understood short term effects distributed evenly throughout the population.

The consequence is that we find consumers much more concerned about technological man-made hazards in food products than over lifestyle hazards, which they believe they understand and are voluntary.

GM foods ascribe almost perfectly to the amplification of food risks model. Research at Newcastle University placed "eating genetically modified food" as fifth (behind hormones, antibiotics, pesticides and animal welfare) out of 16 potential food safety hazards in answer to the question "How worried are you about ...?" Consumers were much "less worried" about hazards associated with diet and health and food hygiene.

Claims are often made about consumer needs and desires. But consumer attitudes to food are very heterogeneous. In a study specifically directed towards GM foods we concluded that the population could roughly be divided into four groups in relation to attitudes to GM foods. [1]

The first, relatively small, group ('the refusers') rejected GM foods on moral, ethical or welfare grounds, rejecting purchase under all circumstances. At the other extreme many more people were very willing potential consumers, being 'enthusiastic triers' - young and keen on modern technology; or 'traditional triers'- low income consumers who saw GM foods as a cheaper alternative. But the majority were 'undecided' and, for them, the decision to accept or reject consumption of GM food products depended on various factors.

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It all depends

The perceived beneficiaries of a new technology dominate its acceptability to consumers. There is a widespread view that producers and 'big business' will reap the benefit of GM technology. But, identify a consumer benefit, and the technology becomes more acceptable. Societal benefits - "feeding the world" - or environmental implications are seen as remote; the impact on the individual consumer counts most.

We see too a 'scale of acceptance', with modification in fruit and vegetables more acceptable than fish, poultry and red meat (in that order). The perceived nature of the modification is also important: interspecies gene transfer is viewed as more acceptable than intraspecies transfer. ■

[1] Ritson, C. and Kuznesof, S. (2005) in Eilenberg and Hokkanen (Eds) An ecological and societal approach to biological control. Springer.

Trust

Openness is everything

With food security and high food prices hitting the headlines, talk has once again turned to the potential of GM foods. Yet even the strongest enthusiasts for GM foods should beware bulldozing the regulatory barriers to the technology in Europe. That would threaten the consumer trust in food that has been hard-won since the GM controversy burst into public view a decade ago, in the wake of BSE and Salmonella.

A study I led of the social and political conditions of trust in food in Europe points to how closely associated popular responses are not only to media coverage, but to the political agenda and the shape of the food supply chain[1]. Distrust in food is not limited to health risks, but raises much wider questions of democracy and power.

The way food is produced and distributed has changed over the last few decades. It has seen technological innovation, globally integrated supply chains, and vast systems of quality assurance and auditing. So, in some senses, our food supply is more actively controlled than ever. Yet these changes have also brought stronger imbalances of power between suppliers and consumers.

One major response to this imbalance has been to focus on labelling, giving consumers a semblance of choice about the products they buy, and the opportunity to make their voices heard through the marketplace. Yet labels don't give consumers direct control over the food they eat. People know that accidents can happen in food supply chains and that, with more complex systems, the impacts of those accidents may increase significantly. They are also very aware that sometimes producers can try to earn a quick buck by mislabelling products or behaving in other unaccountable ways. So they tend to be sceptical towards claims made by food businesses, preferring to trust more independent sources, like the media, experts and official food safety authorities.

Our study has found that people's trust in food varies from country to country according to how well these different players work together. The Scandinavians and the British are generally trusting of their food, while the Germans and Italians are less so, for example. In the high-trust countries, generally, powerful actors, including various market players and food authorities, together seem to manage to produce clarity and consensus over responsibility and control of food. We find more controversy, fragmentation and lack of transparency in the low-trust countries. Britain experienced a crisis of trust in food in the late 1990s, but because of that very crisis, new systems were put in place which allayed that distrust - at least for now.

Experts and regulators used to think trust was a substitute for transparency. Now they know, or at least they should, that transparency is the bedrock of trust.

Trust in food also depends on how standards are set, and on who is doing the setting.

Here, too, the huge imbalances of power, information and knowledge between providers and consumers are crucial. Since there is no way individual consumers can set safety and quality standards on their own, they need standard-setting bodies to act on their behalf. People's trust in food relies on trusting these bodies to put consumers' interests first.

This is not new. In Northern Europe we used to have authoritative expert based bodies which set food standards, which had a remit to serve consumers' interests, but mostly behind closed doors. A spate of controversies, of which GM was one, demonstrated the inadequacy of these established systems, not least because consumers wanted to know how standards were set, and they wanted to have a say in the process. Experts and regulators used to think trust was a substitute for transparency. Now they know, or at least they should, that transparency is the bedrock of trust.

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In Europe, GM food emerged as a symbol of the growing imbalances of power in the food system. Arrogant answers from the companies involved and inadequate regulatory responses to people's mistrust added fuel to the fire. Importantly, however, distrust isn't just about food safety regulation. Control over food is just as much about taste, nutrition, environmental sustainability, farm animal welfare and social justice. In fact it may not always be safety that causes the most worry. People don't always make such sharp distinctions. What is good for the environment is also assumed to be good for people and animals.

Over the past decade, many countries have made progress in tackling this problem. The relative calm right now is a product of political and regulatory reorientation, to which the GM controversy contributed. It is a fragile peace.

The most successful efforts have sought to ensure transparency and openness, independence, and to give some kind of

Openness is everything

voice to consumers. In other words, they have created a 'sceptical eye'. That 'eye' might be a regulatory authority or an independent body. For all the benefits of independence, however, it also exposes a body to being co-opted by the very industry it is meant to control. But whatever shape this organised scepticism takes, it must have the resources - and the teeth - to carry out its responsibilities effectively.

Once established, trust serves as a restraining arm, preventing consumers from jumping to conclusions about the integrity of the food system when 'mishaps' occur. In turn, this can ensure that overly inflexible control mechanisms in the food system can be avoided.

Yet trust has to be proven and renewed. Now is not the time to rest on our laurels. The danger of co-optation is very real, and the technical framing of many food issues makes it all the more so. Consensus is comfortable, but too much consensus stifles debate. Openness is key - we must have efficient watchdogs and experts unafraid of argument, as well as a critical press. These can create the right conditions for ensuring democratic governance and counteracting technocratic tendencies.

Controversies over GM food and other food issues helped to produce a somewhat more consumer-orientated agenda. There is a danger that the current crisis over food security may change that. Producer representatives, both nationally and internationally, may make use of this opportunity to further their causes, including GM food. This would be bad news for consumers in developed as well as developing countries - both in the short term and for the future shape of our food system. ■

[1] Kjaernes, U., Harvey, M. and Warde, A. (2007): Trust in food: a comparative and institutional analysis. Palgrave Macmillan, and on www.trustinfood.org.

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Choice

Less can be more

"Let the people choose whether we have GM foods or not. Let shops stock GM products if they want, and see if people choose to buy them". It sounds a beguilingly reasonable and fair way to resolve the issue. Isn't consumer choice just democracy in action? Isn't restricting choice at best a hangover of the discredited 'Sir Humphrey knows best' approach to public administration and at worst, the reason the Soviet planned economies failed?

The government certainly thinks so. In fields as diverse as schooling, sickness treatment, energy supply, bus services and pensions, no policy announcement is complete without the c-word.

But there is a growing literature (Oliver James, Layard, Tim Jackson) arguing that choice is a very mixed blessing. The wish to choose (for example) a distant hospital is not an emancipation but a sign that the local one is poor. The less confident, canny and educated are least able to make effective choices of, say, pensions or savings. Having to keep choosing is itself an (unchosen) imposition, and a source of anxiety, restlessness and rancour. The extra uncertainties, transaction costs and inefficiencies overwhelm any benefits of choice in (for example) phone number enquiry services. Choice is often illusory: it's the good school that chooses the pupils it wants, not the other way round. Relying on consumers to research, agonise over and implement private decisions to drive public good (for example on animal welfare) is an unfair imposition and an abdication of government responsibility.

Most significantly, choices some people make affect the choices open to others. For example, if enough people choose to get their pensions paid electronically, send e-mails instead of letters, and shop at superstores, a local post office will have too little custom to remain viable and will close, depriving its remaining customers of the option of shopping, socialising and networking locally. Behind what neoliberals like to portray as a value-neutral matter of sensible commercial response to changing market circumstances, lies an intensely political question of whether small increases of ease and convenience to those already highly advantaged should be allowed to result in major losses of social and community support to the more vulnerable and worse off people.

Likewise with GM food. If some people are allowed to choose to grow, sell and consume GM foods, soon nobody will be able to choose food, or a biosphere, free of GM. It's a one way choice, like the introduction of rabbits or cane toads to Australia: once it's made it can't be reversed. So if we want to frame the GM question in terms of choice, the choice to grow, sell and consume GM is only one side of the argument. It needs to be weighed against the choice of all future generations to inhabit a planet free of a new kind of human interference, whose long term effects we cannot possibly be confident will be benign on the basis of the limited short term trials so far conducted.

Ultimately it is our choices that are driving malnutrition and starvation

Profits to GM businesses and cost savings to wealthy consumers would seem a pretty flimsy benefit to justify such a big risk. But the GM lobby has a much more powerful argument: what right have rich-country environmentalists - people for whom higher food prices are only a minor inconvenience - to deny developing-country farmers the ability to grow drought and pest resistant crops, feed their communities, and avoid destitution and starvation? Surely saving lives now trumps speculation about potential future problems for which there is scant evidence?

I will leave others to discuss whether GM really has any value to the poor. But there is a choice angle. The planet has enough bioproductivity to feed everyone. Poor people only starve because we maintain a global economic order which allows rich nations and people to outbid poor ones for the fruit of the land. Ultimately it is our choices - to eat far more meat than we need, to throw away lots more, to fatten livestock on grain rather than grazing and scraps, and now to develop biofuels as a sop to climate change rather than curb our hyper mobility - that are driving malnutrition and starvation.

Contrary to current rhetoric, an important job of government is to restrict choice. The state stops us assaulting, robbing or cheating each other, with the great benefit that we can live in peace and security and do deals with strangers of unknown morals.

We don't let people drive drunk or on bald tyres because of risks to others. Grossly over-consuming bioproductivity is now equally antisocial. So it seems to me that we should turn the choice argument on its head. Instead of opening up the choice of GM, we should be restricting the choices that cause the problems which GM is claimed to help solve. ■

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Democracy

The GM controversy took the UK a step forward but we now risk going backwards

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For five years an intense controversy surrounding GM allowed perhaps the biggest influence on policy in a generation for people outside conventional scientific and political elites. During 1998-2003, participatory democracy, the name for attempts to input people's views to policy making in ways that involve dialogue, rather than mere voting, arrived on the Whitehall map. Since 2003, however, technocratic forces have led a backlash against this power-sharing. Now a new policy term, 'public engagement', is emerging, but with the danger that it could take us back to the public relations led approach to innovation that characterised much of the 1980s and 90s.

The National Consensus Conference on Plant Biotechnology, organised in the early 1990s by the UK biotechnology and biosciences research council (BBSRC), was the first in a line of more or less official, and more or less public, participation processes on GM. The biggest and best-known - the government-sponsored GM Nation? debate - reported in 2003. The intervening years saw a government-funded Public Consultation on Developments in the Biosciences, run by MORI, the Food Standards Agency's (FSA) citizens' jury on GM food, run by Opinion Leader Research, and Prajateerpu, a project co-organised with groups representing smallholder farmers in Andhra Pradesh, India.

These efforts lie at the intersection of two different traditions of politics and research. One is the notion that democracy is about more than elections - a notion at least as old as Ancient Greece, and which crops up in town planning, international development and calls for 'deliberative democracy'. The other is about 'citizen science' - an idea that flourished on the Left in the 1960s and 1970s, as scientists worried about the public control of the innovation process. Both these traditions took a hit during the Reagan-Thatcher era. By the time GM foods came along, UK citizen science had been largely stripped down to a government-led 'public understanding of science' movement, premised on what became known as the deficit model. It assumed that scientists generally knew best and that they merely had a duty to inform the rest of us of the relevant facts. Yet, as voter turnouts have dwindled and scientific controversies boomed, involving the public in decisions about science and technology has looked increasingly attractive to politicians and policy-makers.

Early attempts at public participation around GM foods, such as the BBSRC Consensus Conference, were firmly rooted in the deficit model but, as public pressure mounted, they became more deliberative. The result was a test-bed for public participation in policy that yielded important lessons. The main lesson policy makers have taken away is that public participation in decisions about science needs to happen 'upstream', before investment locks research and innovation into a particular direction of travel. As a result, since GM Nation, 'upstream' public engagement around emerging areas like nanotechnology has grown into a thriving cottage industry.

Yet, for all these 'upstream' processes, our science policy system is far from being democratic. Because they debate technologies that don't yet exist, they clutch at thin air and, when they do say anything awkward, they are often politely ignored. This hints at some other lessons to take from controversy over GM - lessons that are harder to swallow.

The first is that what you debate is crucial. The 1994 plant biotechnology conference was a textbook example of a process that created the illusion of consensus support for a new technology, and it came under heavy fire for that. Yet other initiatives since then haven't escaped this problem. Rather than addressing the issue of the crops being grown in the countryside, people serving on the FSA's citizens' jury were asked only "should GM food be available to buy in the UK?", to which one witness commented "with a question like that I can predict a 'yes' verdict without even needing to give evidence". Having an open question - even letting participants decide the question for themselves - is as vital to good public participation as it is to avoiding survey bias.

Second, the GM experience underlines the need for counterbalances - or what the political analyst Archon Fung calls "countervailing forces" - to be built into the running of any public participation. The point is to offset the weight of the body sponsoring the process. Unless you build some dissent into participation at that level, experience shows you are likely to design a process that tells you what you want or, if the people involved say something uncomfortable, you won't be held to account if you ignore it.

The FSA's citizens' jury shows how not to do it. The agency decided that its own board was independent enough that it didn't need the usual panel of stakeholders to oversee the process. As a result, their pseudo-jury has been widely criticised.

By contrast, GM Nation did have a multi-stakeholder oversight group with an in-built counterbalance. Alongside the scientists, industry representative and officials on the steering board was the director of Five Year Freeze (now GM Freeze), the group leading campaigns for

The GM controversy took the UK a step forward but we now risk going backwards

a moratorium on GM foods. Since government, sponsoring the debate to the tune of £0.5 million, was publicly supportive of the technology, this counterbalance was crucial to GM Nation's credibility.

As a government-owned public participation process, GM Nation remains exceptional for building in a counterbalance. Exploring why reveals a third lesson: while participation processes are all about people power, some of the most crucial power games happen outside of the processes themselves. Introducing a counterbalance means ceding some power over the process to those who might not agree with you. The government only did so in this case because it had to. Threatened with an overwhelming consumer boycott, it was ministers' least-worst option. Compare this with the negligible effect of the biggest protest marches of recent times - notably in 2003 against the Iraq war - and it seems people are a greater political force as consumers than they are as voting citizens.

Finally in Prajateerpu, a process in which I was involved, we learn that when oppressed people do get a voice via a process organised by non-government actors, it doesn't necessarily make for easy listening. Prajateerpu means 'people's verdict', and the verdict of smallholder farmers on the jury was that GM crops would do little to reduce malnutrition in Andhra Pradesh. When the findings were reported in the UK it ruffled feathers at the Department for International Development (DFID), because it challenged a UK-funded plan for development in that part of India. After lobbying by the DFID minister, one of the UK institutes involved in Prajateerpu withdrew the report. The institute only reversed its action and apologised after it faced a worldwide outcry against the censorship of the document and the harassment of the team who had produced it.

Five years on from GM Nation, officially sanctioned involvement processes, now going under the banner of 'public engagement', are springing up in every area of policy-making, particularly those relating to science and innovation. Yet few processes are established with effective counterbalances to potential pro-government bias.

There are now six university-based Beacons for Public Engagement, which are charged with piloting initiatives to transform higher education, allowing those outside the ivory towers more involvement in the research process.

At the Newcastle-Durham Beacon, we see critical evaluation of the use of participation by all those with power in society as part of our work.

Working with interest groups as wide-ranging as the UK research councils (who co-fund the Beacons), trades unions and local community organisations, we hope to contribute to a clearer idea of what post-GM democracy might look like. This comes at a time when many academic researchers, like all three of the UK's main political parties, seem confused about when to direct people to do things, and when to let them 'have their say'. There are signs across much of Whitehall that even weak attempts at public engagement are being ousted in favour of public education campaigns. Last year the government corrupted and then subsequently closed down a public consultation over nuclear power. This year, ministers used the crisis over world food prices to promote the resumption of GM crop planting, against the latest mass of evidence collected from smallholder farmers by the International Assessment of Agricultural Science and Technology for Development.

Rather than yet another set of 'best practice' guides, we need organisations willing to demonstrate good practice and learn from their own mistakes and the reflective practice of others. Underneath it all should be one unifying principle, that mechanisms for people to challenge knowledge-power structures be acknowledged as fundamental to a just society. ■

As told to Tom MacMillan.

Members of the Prajateerpu jury discussing GM crops.

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Power

Seed companies are big but not special

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Power is polarising in the global food supply chain. It lies in the hands of companies that have proprietary ownership of products and services that consumers and other supply chain participants value and for which they are willing to pay a premium.

At one end, and closest to the consumer, are major retailers who control access to the majority of shoppers. At the other end of the chain are life science/seed companies that provide the increasingly proprietary germplasm that is a starting point of the food production process. Between these two poles, supply chain participants are often squeezed unless they have a relevant proprietary offer, such as a branded product much loved by consumers.

The relative importance and 'power standing' of seed companies has risen inexorably in recent years, not least as public sector funding of breeding programmes has declined and private investment has increased. The green revolutionary surge in yields of staple food crops during the latter three decades of the 20th Century was largely taxpayer funded, whereas the anticipated yield increases in the first three decades of the 21st Century are more likely to be financed by company shareholders. Whereas the principal beneficiaries of the former were consumers (appropriately so, as they paid for the R&D wearing their taxpayer hats), those garnering the rewards over the next 30 years will more likely be shareholders, as seed companies will be less inclined to reward consumers and most likely to benefit owners and senior executives.

Globally the seed industry is increasingly specialised and concentrated. This is for sound business reasons: it requires high levels of investment. Conventional breeding of seeds with improved agronomic or consumer benefits (e.g. high yield, disease resistance, great taste/appearance) is a numbers' game - starting with thousands of seedlings showing potential and ending with very few that can be commercialised.

Leading edge gene identification and modification-led breeding is no less, indeed even more, investment hungry. Developing seeds with 'blockbuster' benefits, such as Monsanto's Round Up-Ready range of seeds, requires R&D investment at pharmaceutical industry levels, i.e. 10%+ of total company revenues, and with threshold levels that do not favour 'small' companies with sales of less than US$1 billion. Such companies are international in scope, not simply national, which creates challenges for competition authorities with their national ambit.

There are interesting parallels between proprietary seed companies such as Syngenta and Monsanto and proprietary food product companies such as Nestlé and Unilever - both seek proprietary products, the former through R&D-led investment and the latter through marketing-led investment. Both use scale of business as a key barrier to entry for competitors.

As divisions of, or spin-offs from, international pharmaceutical companies, 'high tech' seed firms, similarly, must balance pure commercial and social considerations in their activities - both make life-giving or life-prolonging products. If, for some developing countries, the medium-term is a food-short and income-constrained future, the morality of marketing premium-priced staple food seed products will be questioned, not least by influential special interest groups. Yet, this issue is, essentially, no different for the international seed companies than it is for the international food manufacturing companies and is resolved through price discrimination by market territory. It is pointless to offer a product at a price that offers insufficient benefit to the purchaser (e.g. the peasant farmer). The challenge is, then, to restrict grey market [1] activity to ensure that product prices reflect individual markets' abilities to pay and not an across-all-markets arbitrage price that discourages further investment by the seed company.

Taking a parochial developed country view, the convergence of food price inflation, high oil prices and concerns about house price deflation are placing pressure on household budgets. Research in the UK and market indicators show that consumers are seeking to constrain their grocery expenditures. This may create a dilemma for those consumers concerned about GM foods - in the future, should they maintain their preference for 'conventional' premium-priced food products, or compromise and embrace food products with GM ingredients (e.g. meat products from GM soya and maize fed animals)?

Two points are germane: like it or not, GM animal feed has been pervasively available for some years; and, for those who wish to consume a non-GM diet, the market will provide this, albeit at a premium price. In a world where commodity markets are fragmenting anyway (for example into identity-preserved ingredients and products with, say, special health benefits, such as omega-3 eggs), non-GM foods will become another segment in an increasingly differentiated market place. ■

[1] Grey market activity is when traders buy a product at its market price in a country where it has lower value, and then sell it in a country where the product retails for a much higher price.

the big question

What lessons from a decade of debate?

Food availability in this time of climate change is reducing globally because of falling production owing to the rising costs of agrochemicals, farm mechanisation and transportation, and because of competition with biofuels. Future agricultural adaptation will be bedevilled by these lasting handicaps.

Multinational corporations, which virtually monopolise genetic engineering, promise us that modified crops will solve all these problems. But this promise sounds as hollow today as it did a decade ago for the following reasons.

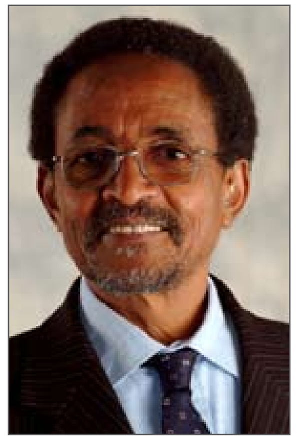
Corporations work for profit. But smallholder farmers can generate virtually no profit for them.

Each GM variety has many patented genes. This means that modified seeds will always be expensive since their price will internalise royalties.

Modified seeds have been successful not in raising productivity, but only in saving labour and in some protection against pests. Neither is of major concern to smallholder farmers, who use their own hands to plant the many varieties and species that satisfy their dietary requirements, thus minimising pest and disease outbreaks.

Rising transportation costs dictate that food be produced locally, mostly by smallholder farmers. The scarcity of inputs is forcing agriculture to become ecological. This means that crops have to diversify to mirror the diversity of local ecosystems. Consequently, genetic modifications would also have to multiply. The resulting reduction in the economies of scale makes agriculture unrewarding for corporate investment.

Smallholder farmers, who have been effective crop breeders for the 10,000 years of agricultural history, will have to continue to be so and modified varieties will be restricted to specialised uses in the industrial sector, such as biopharming.



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What I've learned from the GM foods debate is that our exposure to GM agriculture, now a decade old, is inevitable and not debatable. The UK poultry industry, a major consumer of imported soybean meal, is coming to terms with this fact as soya growers in Brazil (the last bastion of non-GM) opt for genetically enhanced crops in ever greater numbers.

The European livestock industry has for years relied on non-GM soybean meal as a cost-effective source of dietary protein, which has allowed UK retailers to market poultry meat and eggs as GM free. Bizarrely, given that these conditions do not apply to the majority of other conventional livestock production, no retailer is prepared to lead the retreat from GM free claims and face an NGO fuelled consumer backlash.

Conservative estimates are that 80% of Brazilian soya will be GM by 2010, compared to today's 65%. For poultry farmers the cost differential between a non-GM and GM fed chicken is already 5%, which when chicken makes up 40% of all meat consumed, is significant to both consumers and policy makers grappling with food inflation.

British poultry farmers operate on very tight margins in a global market place. Their competitors have embraced GM technology, and the benefits of lower input costs are shared by consumers in lower prices. The unavoidable truth is that feeding a GM free diet to livestock will be difficult in the short term, and impossible in the medium to long term.

What lessons from a decade of debate?

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Five years ago, the government-sponsored GM Nation? public debate revealed widespread scepticism over GM crops and foods. Concerns ranged from environmental risks and possible health effects, to the damaging impacts of corporate control over the food system. Notably, people mistrusted the government's handling of the issue.

This mistrust was well founded. The government continued to fund agricultural biotechnology research with £50 million a year, compared to £2 million directly for organic research, and held a relatively isolated pro-GM position in Europe. However, supermarkets and food manufacturers maintain non-GM food policies and GM crops have not been grown commercially in the UK.

Five years on, little has changed that justifies reappraising the role of GM. Nevertheless, the industry has used climate change, animal feed prices and the food crisis to promote its products. It insists GM crops are necessary, and Europe is an anomaly in resisting them. But commercially-grown GM crops account for just 2.4% of global agricultural land, not a single drought or salt-tolerant GM crop is available commercially, and GM crops do not increase yields.

GM crops are part of the export-led, oil-reliant, model of food production that has created the food crisis. But there is a better way forward, set out in the UN's International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD).

The report, written by 400 scientists and backed by 60 governments (including Britain's), was unconvinced about the role of GM crops in meeting future food needs, leading to the pro-GM US government's refusal to endorse it. The biotechnology industry pulled out of the process despite providing substantial funding. The IAASTD called for a radical shift towards local agroecological solutions for communities around the world, by combining science and technology research with traditional knowledge.

If the British government wants another debate about GM crops it's likely to hear the same concerns that it did five years ago. The question is: how will it respond this time?

What lessons from a decade of debate?

The big question

The food crisis has brought attention to GM technology as a potential way to address world food supplies, and food security for the poor. Ironically, the emerging debates are following the decade old fault lines that bypass key questions of food security: improving productivity constraints of poor farmers and increasing supplies of the food crops of poor people.

GM controversies have been dominated by environmental and anti-globalisation movements, while poverty and development advocates have either followed their lead or remained silent. The key issues have been environmental risk and Monsanto's control of the sector. The issues of impact on the poor and the potential use of this technology for improving the livelihoods, incomes and food security of the world's poorest producers and consumers has been left out of the debate.

The argument that GM technology is a threat to the environment and farmers' control of agriculture, and so a threat to poor farmers, is shortsighted. GM technology can be a pro-poor technology if it is developed and diffused under an institutional environment that would deliver varieties that meet the needs of poor farmers (such as drought resistance) and for the major subsistence food crops of developing countries (such as sorghum and cassava, not just maize, rice and wheat).

But these are not priorities for Monsanto and the other global corporations that lead GM technology. So instead we should look to the public sector. However, in the face of the well-rehearsed arguments of the anti-GM lobbies, and with the notable exceptions of China, India and Brazil, both national and international public agricultural research institutions have eschewed GM. The Consultative Group for International Agricultural Research (CGIAR) that led the Green Revolution in the 1960s only invested $25 million in 2004 in GM research, a mere fraction of $500 million invested by Monsanto that year. This leaves the world with a missed opportunity to increase staple food output to keep pace with world population growth and increase productivity of the millions of poor farmers who make up the majority of the global poor.

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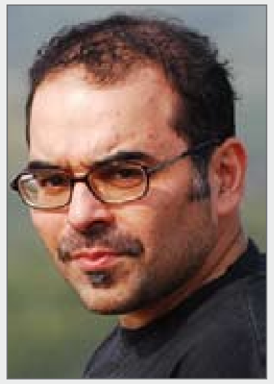
The debate isn't over and there will be no shared consensus on the lessons learnt. What it has taught me, so far, is how deeply political science can be.

The continuing debate over GM foods repeats the patterns and elements of previous controversies over science, technology and food. These include strategies that competing interest groups use to promote or criticise a technology, and to coalesce social and political support for acceptance or rejection. Whether the talk is of Frankenfoods or solving world hunger, the rhetoric is neither entirely true, nor entirely unbelievable.

The mounting investment in biotechnology piles on the pressure to accept GM foods and reduce the regulations that stand in their way. This pressure is felt in challenges to regulation; say at the World Trade Organisation, in the decisions to fund particular research projects and in the editorial decisions of journals. Just recall the debate and controversies over 'genetic-pollution' in maize in Oaxaca or the Pusztai/GM potato case.

Such controversies, and the role science and scientists play in the public eye, are indicative of the strong disagreements over these technologies, their regulation and their use.

It is a fallacy to suggest that the different technologies underlying GM foods have nothing valuable to contribute to improving plant breeding, food production and its nutritive value and in an environmentally sensitive manner. However, the potential and the promise are quite different from the reality. The corporate control of the technology, the global exercise of this control and the actual delivery of the technology do not reflect the promise or potential. Poster-boy interventions like Golden Rice remain inadequate in either convincing critics or persuading others into becoming supporters.



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Can you think of a subject where, even after years of debate, the European Commission pays non-governmental organisations to lobby against it? Where a European government organises and pays for trials, and then suppresses the results, even though they have profound implications for improving health? Where the organic food organisations allow indiscriminate crop spraying using a product which they are adamantly against when delivered extremely precisely for the same purpose?

The subject is GM food.

Agriculture is a dynamic industry, which man has been evolving for 10,000 years. Increasing demands for food, and environmental diversity, with reducing water availability and higher energy costs require highly productive agriculture. Highly productive agriculture needs all the tools available to it.

Europe is being very slow to accept modern GM crops, with less than 0.1% of area planted to GMOs in 2008.

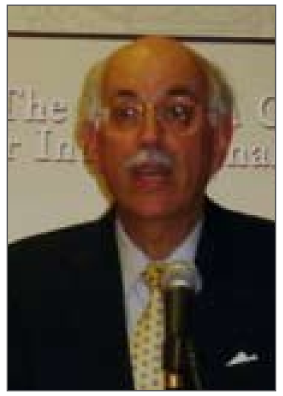
Apart from yield, GM crops can deliver traits unavailable by conventional plant breeding, for example, nutritionally enhanced crops, such as Golden Rice.

There is not one substantiated human or environmental problem associated with GM crops. The first medicine is food. Above all else, agriculture has to be productive. Productive agriculture is sustainable, and good for the environment.

A more rapid softening of European attitudes to GMO crops could be a major contributor to the world food shortage. It could benefit the poorest of society in developing countries, who were already spending over 70% of their income on food daily, before the huge percentage price rises over the past year.

The big question

What lessons from a decade of debate?



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Despite years of open debate on GM, efforts to introduce GMO seed technology to developing countries, particularly Africa, have had mixed results.

But the 100% increase in grain prices over the past two years has put severe stress on food security in some of the poorest countries, and measures must be found to mitigate this stress.

Africa is the most food insecure region in the world, with the lowest agricultural productivity and highest rates of acute malnutrition. We must increase funding for agricultural development there, including the development of GMO seed designed for the continent's agro-climatic growing conditions.

Half of all improvements in agricultural productivity in the developing world since 1980 are attributable to improved seed varieties. GMO seed technology will not solve all of Africa's agricultural problems, but it can make a great contribution to addressing the problems of drought, product storage, insects, plant diseases and poor yields.

Misinformation in developing countries about the science of GMO seed technology must be corrected through more public debate, discussion, and exposure for government officials, the media, and the public of its substantial benefits and limited downside. Scientific evidence is the best defence of GMO technology.

African agricultural ministries must be supported to develop the institutional capacity to review and oversee the introduction of seed technologies, including GM, so they can install and manage their own regulatory systems with confidence.

More money must be invested by international institutions, bilateral aid agencies, and African governments in agricultural development and rural roads for African farmers to benefit fully from GMO technology. Western governments, particularly the US and the EU, must avoid dragging African countries into their trade disputes over GMO food and seed, causing widespread misinformation and distortion of evidence on GMO technologies. These western countries should know better.

The main lesson of the GM debate is that (however tempting) it is never wise for politicians to become too fixed on technical solutions to complex problems such as hunger and obesity.

In June this year UK Environment Minister, Phil Woolas, called for a national debate on whether we should grow GM crops in the UK as a response to the global food crisis. He forgot that the reason we don't grow GM crops is that in 2004, the government announced that GM oilseed rape and beet would be banned. They were banned because they would cause harm to farmland biodiversity which the government had previously spent huge sums of public money trying to protect from the impacts of intensive farming. A third GM crop, fodder maize, was voluntarily withdrawn by its developer Bayer CropScience.

In recent years, UK government annual spending on biotechnology research has been over 20 times that for organic farming. The Department for International Development's agricultural policy paper in 2005 left no doubt about Labour's faith in biotechnology, because it "has the potential to provide significant benefits for poor people".

Contrast this with the findings of the International Assessment on Agricultural Knowledge, Science and Technology for Development (IAASTD) which clearly set out the difficulties of producing a balanced diet for all as a complex mix of social, economic and cultural factors in which technology has to be applied with the consent of the people it is intended to benefit. IAASTD's peer reviewed process found no evidence that GM crops yielded more than conventional ones and called for more emphasis on an agroecological approach to farming.

The British government should engage in a real discussion about why more people on the planet are either overweight or calorie-starved. Neither group benefits from the unsophisticated solutions adopted so far.

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What lessons from a decade of debate?

The big question

The current food crisis has created renewed interest in GM technology and given an upwind to the agbiotech sector, which is suggesting afresh that transgenic crops are the solution to increasing food production.

But despite 10 years of debate and tall claims made by the proponents of agricultural biotechnology over the last decade, almost all varieties important for food security are still emerging from conventional breeding, which has been far more effective. It has offered a greater number of varieties of both food and cash crops compared to transgenic technology. If the vast sums of money and resources being invested in genetic engineering were to be invested in conventional breeding and in crops and traits of importance to developing countries, it is certain that we would see problems in agriculture being solved more quickly and more cost effectively.

The question of the safety of GM foods is still outstanding, and we must also remember that genetic improvement - either through the transgenic or the conventional route - will not result in better crops unless there are accompanying skills in agronomy, farm management and optimal supplies of resources, which are often scarce in developing countries. The over expectation from any one agent of change - genetic, biological or chemical - is unlikely to solve agricultural problems and could end up being a recipe for disaster.

Safe and meaningful GM technology may one day play a role in increasing food production and alleviating hunger but that day has not yet come.

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GM as a solution to the hunger problem is back on the agenda, due to the world food crisis. It is being pushed to the forefront as one of the major solutions to boosting yields in developing countries. The non-believers are accused of being amoral, because they refuse the hungry a life-saving technology. Fortunately we have the IAASTD Report on our side now. What these scientists proclaim is that GM has not been effective, and new promising innovations are not to be found in the pipeline. For industry this is as bad as it can get.

Industry is happy to debate the biosafety issue, because it thinks it can win that debate. But to argue that their products are meaningless hits GM manufacturers right in the heart. Herbicide tolerance and Bt technology, the two main technologies they offer, are not convincing, neither for small farmers nor consumers. Poor people still weed by hand, and resistance management of Bt is a very cumbersome procedure for small farmers.

If 'Dolly is dead', so is GM. The technology is too rough around the edges to produce smart products and precise results. It is ridiculous to think that complete control over nature is possible. GM is only instrumental for gaining ownership over nature by patents. It is a tool of power, not innovation. It will never be a relevant technology for anything to do with food and agriculture.

The debate over GM foods has been unhealthily polarised between those for and those against. What is needed is for both sides to talk with each other. The outcome of the discussions between the parties should be articulated in ways that are honest, down-to-earth and understandable by the lay public. The debate must be framed within universally accepted ethical codes, recognising that while food and agricultural industries are vital economic activities on which the vast majority of the world's poorest people depend, the products are inherently ethical in nature. Food is essential for human survival, it is a major determinant of human well-being, and hunger and malnutrition impair human health. The way in which food is produced has important impacts on natural resources and hence the welfare of future generations.

There is also a wide consensus that nature itself must be valued. Thus mankind's increasing ability to modify nature is creating tensions with our ability to preserve the splendour and integrity of nature. On a small planet we must also pay due respect to the diverse cultural values placed on agriculture, food and nature.

We must approach the exploitation of technology to feed increasing numbers of people in ways that are consistent with universally accepted ethical codes. Humanity must find the genius to reconcile the different demands that does not exclude a-priori potential technical options without rational evaluation of the trade-offs. If scientists, policy makers and civil society are unable to agree on the way forward they will create space for self-interested groups with less concern for ethics.

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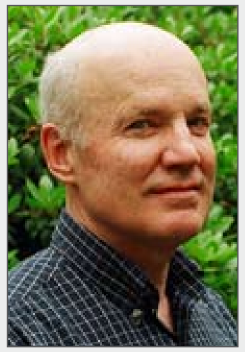
the big question

What lessons from a decade of debate?



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Governments first began placing significant numbers of GMO foods and crops on the commercial market in 1995-96, a dozen years ago. The most important thing we have learned since then is that the regulatory approach taken toward this technology by the United States has been adequate, so far, to provide a high level of safety (comparable to that for non-GMO foods and crops) for both human health and the environment. We know this because by 2004 every important scientific authority in Europe had issued a finding that no new risks to human health or the environment had been found from any of the GMO foods or crops placed on the market so far.

We also know it because the vast majority of those GMOs placed on the market at that point had been approved in the United States, using a standard risk-assessment/risk-management approach rather than a European "precautionary" approach (that can keep products off the market so long as uncertainties not yet tested for remain).

By 2004, the scientific authorities certifying they had found no new risks from the GMOs on the market included the French Academy of Sciences (2002), the French Academy of Medicine (2002), the World Health Organisation (2002), the Royal Society (2003), the International Council for Science (2003), the British Medical Association (2004), the German Union of Academies of Science and Humanities (2004), and the United Nations Food and Agriculture Organisation (2004).

The debate on GM foods is a Rorschach where every culture constructs and projects its fears or hopes of science on to GM. While Europe and America saw it as a debate on enlightenment, India read it as a 'downloaded' debate.

The excitement, with a few exceptions, was imported.

As it developed, GM food was seen as the alternative to the ghosts of Malthus. But GM, rather than the cause of a certain kind of agriculture, was more a symptom. To isolate agriculture from culture was ridiculous.

What GM reflected in India was the site where desire met scientific research and innovation met memory. Where India failed was to balance the ethics of memory (the diversity of seeds) against the ethics of innovation.

For me, the debate on regulating GM that has rumbled on this last decade, has become a surrogate debate for the nature of state rather than a meditation on the risk sciences. GM had not entered the folk imagination; therefore we failed to argue it out as a cosmos, a religious imagination. The debate was not a systemic philosophy - just a set of recipes or techniques, a technology not a science. Food was not central to the imagination. The seed was a metonym for the new body.

The debate threatens to become more complex in a sociological sense, where GM will be used as an invidious weapon against small farmers, triggering an enclosure movement in agriculture. What one misses is ethics that is political, a sense of food that is agricultural and cultural, and a politics that locates the GM debate within a discussion of civilisation.

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The knowledge economy

Good inventions drive more innovation

This summer the agricultural biotechnology industry began a concerted effort to get GM foods back onto the political agenda in the UK. The industry argues that GM crops will bring wider economic benefits to the UK. This claim rests on the assumption that the UK must increasingly turn to the 'knowledge economy' for the creation of jobs and wealth through applying new knowledge to the innovation of products and services.

On the surface this is an attractive argument. However, it is important to unpick the relationship it implies between technology and innovation. All too often the presence of technology, especially science-based technology, is taken as an indicator of innovation. But by no means is this always the case. When considering a technology's contribution to the economy, the knowledge required to develop a specific technology matters less than its capacity to enable further innovation - what could be called its 'inventive potential'.

Several decades of scholarship on the relationship between technology and society demonstrate that different technologies enable different forms of interaction. Just think of the new modes of communication made possible by text-messaging. Invention is a form of interaction, and some technologies enable further invention more readily than others. A useful analogy is the contrast between two toys: a kit for building a model aeroplane and lego. While the first may be more sophisticated in that it has more precisely designed parts, lego's attraction lies in its capacity to be endlessly recombined. Here it is the apparently simpler technology that has the higher inventive potential.

To judge the contribution of a technology such as GM to the knowledge economy it is necessary to consider the extent to which it enables further innovation. And to answer this question we should take a broad view of where this innovation may occur.

Let's be clear - from an economic point of view the GM industry itself is not large. The global value of GM traits in 2007 is estimated by the industry to be US$6.9 billion, only about 1% of the revenues of the pharmaceutical industry. As far as national economic policy is concerned it is significant that none of the six GM firms is based in the UK. So the greatest economic impact of GM technology in the UK will not be on the biotech industry itself but on farming and food production. Therefore assessment of the inventive potential of GM should focus on the wider food production industry.

A significant area of innovation in agriculture and food has centred on the development of regional quality foods. Here innovation has meant developing new products with strong local identities, and bringing these products to new markets. The economic significance of localised foods is illustrated by the success of the whisky industry, which in 2005 accounted for nearly a quarter of all the UK's food and drink exports.

Localised innovation can benefit from science-based technologies. Whisky again provides an example. Academic research in molecular biology is helping to understand and improve fermentation yeasts upon which whisky distilling depends. Here science is applied in such a way as to support the distinctive local character of whisky.

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The importance of localism is not limited to rich countries. In the recent UN and World Bank assessment of the global food system, a strong conclusion was that more research was needed to support diverse site-specific agricultural practices. It recommended the targeted development of technologies appropriate to small-scale farmers.

So whether considering the questions of the food industry in the UK, or the sustainability and supply of food globally, the importance of local innovation is apparent. Any judgement of a new technology must include consideration of its capacity to support locally differentiated innovation. How then does GM technology fare against this criterion of inventive potential?

According to the GM industry's own figures, the range of commercial GM crops remains narrowly focused on only two types of GM traits - herbicide resistance and insect tolerance - and on only four crops - soya, maize, cotton and oilseed rape. There are only six agbiotech companies worldwide, three based in the USA and three in the EU.

The global ambition of GM industry is characterised by a one-size-fits-all approach to technology. Patented GM traits lock farmers into using particular pesticides and fertilisers, which (not coincidently), are produced by the same firms. Intellectual property regimes concentrate innovative capacity in the labs of six global companies, reducing the scope for local experimentation and invention. GM technology as it is currently developed does not foster wider innovation in the rural economy. In fact GM has a negative inventive potential inasmuch as it promotes standardised farming practices.

This 'command and control' vision of GM technologies is diametrically opposed to the kinds of localised and site specific innovation required to support economically and environmentally sustainable rural livelihoods. There are no straightforward lessons for UK ministers as they consider GM crops in the light of innovation policy. However, it is vital they see beyond the apparent sophistication of a technology and instead ask hard questions about its inventive potential. ■

Sustainable agriculture

Small farms show big promise

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World agriculture appears to be approaching a crossroads. The globalised economy has placed a series of conflicting demands on existing cropland. This land has to produce food for a growing human population, as well as meet the increased demands for biofuels; and it must do so in a way that preserves biodiversity and reduces greenhouse gas emissions, whilst representing a profitable activity to millions of farmers.

These pressures are setting in motion a global food system crisis of unprecedented scope that is already signalled by food riots in many parts of the world. It threatens the livelihoods of millions more than the current 850 million hungry people, and is the direct result of the dominant industrial farming model - a model dangerously dependent on fossil fuels and the largest source of human impact on the biosphere.

Ninety one percent of the world's 1.5 billion hectares of cropland are under annual crops worldwide, mostly monocultures of wheat, rice, maize, cotton, and soybeans highly dependent on inputs of petroleum-derived fertilisers and pesticides, and huge amounts of irrigation water.

While subsidised grain monocultures may have temporary economic advantages for farmers, in the long term they do not represent an ecological optimum. With the world's food supplies facing an increased vulnerability to climate change, the drastic narrowing of cultivated plant diversity has put the world's food production in greater peril. The social and environmental impacts of local crop shortfalls resulting from such uniformity can be considerable in this era of climatic extremes as crop losses often mean ongoing ecological degradation, poverty, hunger and even famine.

There are now so many pressures on dwindling arable ecosystems that farming is overwhelming nature's capacity to meet humankind's food, fibre, and energy needs. The tragedy is that agriculture depends on the very ecological services (water cycles, pollinators, natural pest control, fertile soil formation, local weather, etc) that intensive farming continually degrades or pushes beyond their limits.

Humanity is rapidly beginning to understand that the fossil fuel-based, capital-intensive, industrial-agricultural model is not working to meet global food demands. Soaring oil prices are increasing production costs and food prices, which have already escalated to the point that today one dollar buys 30% less food than one year ago. This situation is rapidly being aggravated by farmland being turned over to biofuels. Climate change has reduced crop yields as a result of droughts, floods, and other unpredictable weather events. Expanding land areas devoted to biofuels and transgenic crops are further exacerbating the ecological footprint of vast monocultures. Moreover, industrial agriculture contributes at least one-quarter of current greenhouse gas emissions, mainly methane and nitrous oxide. Continuing this dominant degrading system, as promoted by the current economic paradigm, is no longer a viable option.

The immediate challenge for our generation is to transform industrial agriculture by shifting the world's food systems away from reliance on fossil fuels. We need an alternative agricultural development paradigm: one that encourages more ecological, biodiverse, sustainable, locally based and socially just forms of agriculture. Fortunately such spaces of hope already exist in the world, as thousands of new and alternative initiatives are flowering across the world to promote ecological agriculture, preservation of the livelihoods of small farmers, production of healthy, safe and culturally diverse foods, and localisation of distribution, trade and marketing.

Many of these sustainable models in the developing world are rooted in the ecological rationale of traditional agriculture, which represents thousands of examples of successful forms of community-based local agriculture. These microcosms of traditional agriculture offer promising model areas around the world by promoting biodiversity, thriving without agrochemicals, and sustaining year-round yields. Such systems have fed the world for centuries, while conserving ecological integrity through the application of indigenous knowledge systems.

Small farmers key for the world's food security

Although 91% of the planet's 1.5 billion hectares of agricultural land are devoted to agroexport crops, biofuels and transgenic crops to feed cars and cattle, millions of small farmers in the developing world produce the majority of staple crops needed to feed the planet's rural and urban

populations. In Latin America, around 17 million peasant production units occupying close to 34.5% of the total cultivated land with average farm sizes of about 1.8 hectares, produce 51% of the maize, 77% of the beans, and 61% of the potatoes for domestic consumption.

Africa has approximately 33 million small farms, representing 80% of all farms in the region. And while Africa now imports huge amounts of cereals, the majority of African smallholders with farms below two hectares produce a significant amount of basic food crops with virtually no or little use of fertilisers and improved seed. The majority of 200 million rice farmers in Asia farm less than two hectares and make up the bulk of rice produced in Asia. Small increases in yields on these small farms that produce most of the world´s staple crops will have far more impact on food availability at the local and regional levels, than the doubtful increases predicted for distant and corporate controlled large monocultures managed with high-tech solutions.

More productive and resource conserving

Although the conventional wisdom is that small family farms are backward and unproductive, research shows that small farms are much more productive than large farms if total output is considered rather than yield from a single crop.

It's true that a large farm may produce more corn per hectare than a small farm in which the corn is grown as part of a polyculture that also includes beans, squash, potato and fodder. But integrated farming systems in which the small-scale farmer produces grains, fruits, vegetables, fodder, and animal products out-produce yield per unit of single crops such as corn (monocultures) on large-scale farms.

In polycultures developed by smallholders, productivity in terms of harvestable products per unit area is higher than under sole cropping with the same level of management. Yield advantages can range from 20% to 60%, because polycultures reduce losses due to weeds, insects and diseases and make a more efficient use of the available resources of water, light and nutrients.

In overall output, the diversified farm produces much more food, even if measured in dollars. In the USA, data shows that the smallest two hectare farms produced $15,104 per hectare and netted about $2,902 per hectare. The largest farms, averaging 15,581 hectares, yielded $249 per hectare and netted about $52 per hectare. And these small to medium sized farms are netting higher yields with much lower negative impact on the environment.

In effect they are 'multi-functional'- more productive, more efficient, and contribute more to economic development than large farms. Communities surrounded by populous small farms have healthier economies than communities surrounded by depopulated large mechanised farms. Small farmers also take better care of natural resources, including reducing soil erosion and conserving biodiversity.

The inverse relationship between farm size and output can be attributed to the more efficient use of land, water, biodiversity and other agricultural resources by small farmers. So in terms of converting inputs into outputs, society would be better off with small-scale farmers. Building strong rural economies in the global South based on productive small-scale farming will allow the people of the South to remain with their families and help to stem the tide of migration to cities. And as population continues to grow and the amount of farmland and water available to each person continues to shrink, a small farm structure may become central to feeding the planet, especially when large-scale agriculture devotes itself to feeding car tanks.

Models of sustainability

Despite the onslaught of industrial farming, the fact that thousands of hectares under traditional agricultural management remain, shows a successful indigenous agricultural strategy of adaptability and resilience. These microcosms of traditional agriculture that have stood the test of time, can be found almost untouched over 4,000 years in the Andes, MesoAmerica, south east Asia and parts of Africa. They offer promising models of sustainability by promoting biodiversity, thriving without agrochemicals, and sustaining year-round yields even under marginal environmental conditions. The local knowledge accumulated during millennia and the forms of agriculture and agrobiodiversity that this wisdom has nurtured, comprise a Neolithic legacy embedded with ecological and cultural resources of fundamental value for the future of humankind.

Recent research suggests that many small farmers cope with and even prepare for climate change, minimising crop failure through increase use of drought tolerant local varieties, water harvesting, mixed cropping, opportunistic weeding, agroforestry and other traditional techniques. Surveys conducted in hillsides after Hurricane Mitch in Central America showed that farmers using sustainable practices such as 'mucuna' cover crops, intercropping and agroforestry suffered less 'damage' than their conventional neighbours.

The study, spanning 360 communities and 24 departments in Nicaragua, Honduras and Guatemala, showed that diversified plots had 20% to 40% more topsoil, greater soil moisture, less erosion and experienced lower economic losses than their conventional neighbours. This proves that a re-evaluation of indigenous technology can be a key source of information on adaptive capacity and resilient capabilities exhibited by small farms - of strategic importance for world farmers. And indigenous technologies often reflect a worldview and an understanding of our relationship to the natural world that is more realistic and sustainable that those of our Western European heritage.

Small farms cool the climate

While industrial agriculture contributes directly to climate change through no less than one third of total emissions of the major greenhouse gases - Carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), small biodiverse organic farms have the opposite effect by increasing sequestration of carbon in soils. Small farmers usually treat their soils with organic compost materials which absorb and sequester carbon better than soils that are farmed with conventional fertilisers. Researchers have suggested that the conversion of 10,000 small to medium sized farms to organic production would allow them to store so much carbon in the soil that it would be equivalent to taking 1,174,400 cars off the road.

Sustainable agriculture

Most small farms also use significantly less fossil fuel in comparison to conventional agriculture, by relying on organic manures, legume-based rotations and diversity schemes to enhance beneficial insects. Farmers that live in rural communities near cities and towns and linked to local markets, avoid the energy wasted and gas emissions associated with transporting food hundreds and even thousands of miles - further evidence that small farms can help cool the climate.

Another way for agriculture is not only possible, but is already happening in the developing world involving millions of small farmers. Their farms display high levels of agrobiodiversity in the form of variety mixtures, polycultures, crop-livestock combinations and/or agroforestry patterns. And the same key principles underlie the sustainability of these farms: use of local energy, material and labour resources, species diversity, organic matter accumulation, the enhanced recycling of biomass and nutrients, the minimisation of resource losses through soil cover and water harvesting, and the maintenance of high levels of functional biodiversity to encourage beneficial fauna such as soil organisms, pollinators and natural enemies - all key for plant health.

Modelling new agroecosystems using diversified designs adopted by small farmers are extremely valuable to every farmer whose systems are collapsing because of escalating debt linked to oil prices, pesticide or transgenic treadmills or climate change. All farmers can learn a lot from indigenous modes of production, as these systems have a strong ecological basis, maintain valuable genetic diversity and lead to regeneration and preservation of biodiversity and natural resources. Traditional methods are particularly instructive because they provide a long-term perspective on successful agricultural management under conditions of climatic variability. This learning needs to happen rapidly before this ancient ecological legacy is lost forever, the victim of industrial agricultural development. ■

Food security and development

We need dialogue not rhetoric

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The recent IAASTD Report begins by highlighting the fact that science and technology have been relatively successful in increasing agricultural productivity, but much less successful in dealing with the complex social and environmental problems, and sometimes consequences, that new technologies may raise.[1] The report identifies increasingly constrained environmental conditions and globalisation as two additional factors that must be accounted for in the development of new agricultural technologies.

In the 1960s, the Green Revolution highlighted both the promise and the limitations of technological innovation as a means to ameliorate food security and promote development. It was conceived of as a package of technologies; high-yielding hybrid varieties of cereal crops that would respond well to intensive management and would significantly improve yields no matter the context in which they were applied. The scientific rationale was that problems of rising populations and unproductive agriculture could be solved by focusing on the 'isolable technical problem' of low yields.

This perspective would inevitably lead to the promise and promotion of a technological solution, new seed varieties. This approach was not without success. Between 1961 and 1985 yields of cereal crops such as wheat, rice and maize doubled in developing countries. However, yield increases varied in different environments, and were much more impressive in environments that most closely mirrored those of the research centres where the seeds were first developed.

Furthermore, optimum yield increases depended on the full application of management practices, irrigation and generous use of fertiliser, and this was something that only more wealthy farmers could afford. While aggregate food production certainly increased, when one looked a little more deeply, poorer farmers, and particularly poorer farmers living in more marginal environments, saw little if any benefit. The Green Revolution served to amplify many rural inequalities.

Dialogue is scant, if two sets of rhetoric can ever be called 'dialogue'

The Green Revolution represents a linear version of agricultural innovation, primarily driven by the public sector. Scientists isolate an element of a complex problem that they are able to deal with, a technology is developed from their research, and ultimately farmers adopt the technology. Some farmers adopt new technologies earlier than others, and some may never adopt new technologies. Quite often farmers need to be educated about the benefits of these technologies. Technologies move in one direction, from lab to field, and there is little if any dialogue between farmer and scientist.

Many of the proponents of agricultural biotechnologies, what we might dub the 'gene revolution', similarly see agricultural innovation as the development of a technology that can be universally applied. Many opponents of agricultural biotechnologies argue that locally specific agriculture - building on indigenous knowledge and perhaps adopting an organic philosophy - is the most appropriate approach in developing countries. These perspectives frequently talk across each other (above the head of the developing country farmer), and dialogue is scant, if two sets of rhetoric can ever be called 'dialogue'.

Dialogue, though, lies at the heart of new thinking about agricultural innovation for development. As technologies become more complex, and the key players involved in developing new technologies start to include the private sector, NGOs and advocacy groups, our understanding of how innovation works has also become more complex.

We have come to recognise that innovation is not something that takes place parallel to economic production and development in a lab or experimental rice paddy. In reality innovation interacts with economic production through a complex process that is decidedly 'non-linear' and intrinsically systemic. Technological development is not characterised by processes of refinement, optimisation and

Food security and development

adoption over time, rather the characteristic features are learning and continuous change.

Thinking in terms of an innovation 'system' allows us to view agricultural innovation in a much more holistic way, encompassing all the organisations that actually make up a technological system. This might include stakeholders who are not so evidently part of the linear system of transfer of technology, for example NGOs or farmers' interest groups.

This reveals the public sector in a broader context and in doing so allows us to identify what its most appropriate role in encouraging innovation might be. Similarly it allows the private sector to identify new opportunities and partners, and provides farmers with new ways to express their needs.

We need to place the sharing of knowledge at the centre of our thinking, as it is through knowledge that actors effectively interact in any system. This may mean relatively simple interventions such as assisting farmers in the purchase of mobile phones to allow them to discern market prices before they decide which market to take their produce to, or how best to price it, as has been the case with perishable fruit producers in Tanzania or grain producers in Niger.

In Peru, Bolivia and Ecuador an award-winning project called Papa Andina links up all members of potato value chains in fora in order to build trust between producers, processors and distributors and share ideas about what potato-derived products should be developed for faraway urban markets. Sharing information and learning has allowed thousands of small-scale potato producers to diversify their livelihoods, more effectively link with markets and increase their incomes.

Innovation systems approaches for developing country agriculture also allow farmers to articulate their technological needs in ways that may not have been possible in the past. For example, the private sector often cannot or will not respond to farmers' demands for new technologies, either because farmers cannot make themselves heard through markets or there is simply no likely profit to stimulate their engagement. We can work out ways to bridge these knowledge gaps in the system, perhaps via new forms of organisation or partnership. A public-private partnership might bridge such a gap in the system, as the public sector partner may better understand what farmers want and provide some sort of financial stimulus to encourage the private sector to become involved.

Innovation by its very nature is complicated. International Development Enterprises (IDE), an NGO based in South Asia, has spent almost two decades supporting the innovation of treadle pump technologies for small-scale technologies. These simple foot-operated water pumps offered many advantages to farmers in Bangladesh but did not catch on. IDE recognised this was due to gaps in the system and sought to develop a complete value-chain. After initially developing and selling the pumps themselves, IDE withdrew from production and offered technical support to small start-up companies to fabricate the pumps and subsequently promotes the use of the pumps through training and facilitation. Since 1984 over 1.5 million treadle pumps have been developed, fabricated and sold.

As technology becomes increasingly complex, so do the innovation systems and the efforts needed to engage with farmers. VITAA, a project to promote the development and widespread planting of carotene-enriched sweet potatoes across Africa, is an example of a learning network that links together researchers in Latin America with NGOs in Africa and village-level farmers' groups. This network includes international scientists, home economists, development workers, female farmers and market traders all sharing knowledge and working to develop and grow new varieties of vitamin A enriched sweet potato and new products that be derived from them and sold for profit.

So-called 'Golden Rice', a genetically engineered bio-fortified variety of rice, has been developed through a partnership that spans seven countries, almost twenty organisations and the accumulation of decades of scientific (and legal) expertise.

Debates about the appropriateness of GM crops will be rendered moot

Innovation systems thinking has also underlined the pressing need for scientists to communicate directly with farmers. Projects such as PETRRA (Poverty Eradication Through Rice Research Assistance) where research was only funded if scientists could demonstrate partnerships with farmers and farmers groups, and methodologies such as 'mother-baby trials' where new agricultural practices and technologies are developed and tested through trials and re-trials conducted in farmers' fields in partnership between scientists and the farmers themselves, underline the need to develop new ways to build partnerships, share knowledge and learn in order to promote pro-poor agricultural innovations

The IAASTD itself represents something of a departure for agricultural assessments in that it recognises multiple knowledge bases, the complex contexts and practices of agriculture and the multiple needs of the farmer. In doing so it highlights 'collaboration' as one of its core messages. Innovation involves using new ideas, new technologies and new ways of doing things in places or by people where they have not been used before, and ultimately for innovation to flourish we must enable and support farmers to interact and learn as part of complex systems and networks.

Through supporting farmers, building developing country research capacity, stimulating local private sectors and implementing policies, practices and mechanisms to support these actors to interrelate, share and learn, agricultural technologies will be developed that are embedded within local agricultural, social, economic and environmental contexts rather than developed as abstractions of externally perceived problems. When this happens, debates about the appropriateness or inappropriateness of the Green Revolution or of GM crops will be rendered moot (in developing countries at least) as new agricultural innovations will be developed via dialogue, in context, reflecting farmers' needs, not rhetoric, theory or ideology. ■

Micronutrients and hidden hunger

A mix of methods

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Micronutrient malnutrition - frequently called hidden hunger - affects over a half of the world's population, particularly women and preschool children. Hidden hunger has economic consequences as well as health ones and, at its most extreme, can lead to death. Other outcomes include blindness, poor cognitive development, reduced growth, lower worker productivity, higher morbidity and undesirable pregnancy outcomes.

Since the early 1980s an immense amount of effort and resources has gone into identifying the extent and severity of micronutrient deficiencies in developing countries. Programmes to control these deficiencies - diet diversification through nutrition promotion, supplementation and food fortification - have met with variable levels of success.

Although nutrition promotion is an important part of controlling nutritional deficiencies, it will not eradicate micronutrient deficiencies on its own. Supplementation programmes tend to be pharmaceutical-based, directed at specific age and physiological groups rather than to sectors of society. They also depend on effective healthcare delivery systems.

Food fortification programmes are more amenable to controlling micronutrient deficiencies because they depend on people participating in the market economy, and can be targeted according to the magnitude of the micronutrient deficiency.

More recently, a new public health approach to controlling key micronutrient deficiencies in developing countries has emerged. This centres on biofortification of staple food crops with vitamin A, iron and zinc.

The staple diet of poor communities in developing countries tends to be simple and monotonous, with a low density of bioavailable micronutrients.

Households keeping livestock and chickens may have access to dairy products and eggs that are important sources of micronutrients. Fruit, unless available locally, is often a luxury - as are many vegetables. In addition, people in poor communities are continuously exposed to infections that increase micronutrient requirements which, if not met, increase their susceptibility to micronutrient deficiencies.

For the rural poor, access to whole-grain cereals, legumes, nuts, fruit and vegetables may be reasonably good. But the urban poor find themselves in a more precarious situation, unable to produce food for home consumption, and forced to participate in the market economy. This means their diet tends to be based on refined flours, sugar and oils with an even lower nutrient density than the rural poor.

Changing eating habits is a challenge, so strategies to increase the supply of micronutrients without requiring a radical dietary change are required. Two such strategies exist - food fortification and biofortification. There is evidence to support the effectiveness of the first but not the second, which is still in the developmental phase. However, there are relative strengths and weaknesses in both strategies, and both need to be considered as medium-to-long term methods of controlling micronutrient malnutrition.

Food fortification works by restoring (or enriching) food with micronutrients to pre-processing levels, or adding micronutrients at levels higher than found in the original (or comparable) food. In other words, it deliberately increases the concentration of micronutrients in food.

Biofortification uses traditional breeding methods or modern biotechnology - including genetic modification - to increase the concentration of micronutrients in staple crops. This can be done by enabling the plant to synthesize vitamins (or their precursors) or increase the uptake of minerals. It can also be done by improving micronutrient bioavailability, which requires reducing the amounts of dietary absorption inhibitors or increasing the amounts of dietary absorption enhancers that are naturally present in the edible portion of food.

Biofortification and food fortification both capitalise on the regular daily intake of a consistent and large amount of staple food by every member of a family. And because staple food predominates in the diets of the poor, both strategies implicitly target low-income households.

An important difference between food fortification and biofortification is that the latter could potentially deliver

Hidden hunger and micronutrients

naturally fortified food to undernourished people in rural areas, where there is limited access to the commercially-marketed fortified foods that are more readily available in urban areas. To work, however, biofortified crops will have to be accepted by farmers and consumers, and they will both be influenced by the visibility of the trait and the development of market networks.

Visible traits are not trivial matters. They include colour changes associated with high provitamin A carotenoid concentrations or changes in dry matter content that alter the sensory properties of a food, and potentially food choice.

Invisible traits, such as higher concentrations of minerals, do not alter the sensory properties of the food, and are unlikely to affect food choice. However, if the trait is invisible it is not easy for consumers (and farmers) to identify the nutritionally superior varieties, not to mention the ethical issues related to whether consumers are told that food with invisible traits have been biofortified.

We can already increase the micronutrient density of staple foods using conventional breeding. There is enough genetic variation in the levels of provitamin A carotenoids, iron, zinc and other minerals among cultivars to select nutritionally appropriate breeding materials. Orange-flesh sweet potato lines with over 200µg β–carotene/g, for example, have already been identified. We can also combine the high micronutrient-density trait with high yield. For example beans with improved yields and grains with double the quantity of iron have been bred conventionally.

To work biofortified crops will have to be accepted by farmers and consumers

Transgenic approaches may prove to be more advantageous than conventional breeding. The best-known example is Golden Rice, in which β–carotene that does not exist in conventional rice has been added. Other transgenic research is exploring the use of an endosperm-specific promoter to deposit iron in the rice's endosperm so that it isn't milled away with the aleurone layer during polishing.

A crucial element of both biofortified and fortified foods is bioavailability, especially for minerals. Bioavailability is determined by the nutritional status of the host, and other food factors, including the composition of the meal and chemical form of the nutrient. For instance, in food fortification the particle size and solubility of the iron compound influences how much iron is available for absorption. There is growing evidence that the bioavailability of the iron storage protein in plants - plant ferritin - is better than that of most iron fortificants. Moreover, plant ferritin may not be influenced by phytate, which is a major iron absorption inhibitor.

Transgenic approaches can be used to enhance iron bioavailability by overexpressing the ferritin iron in beans, which contain a lot of phytate, by increasing iron uptake by plant roots. It is important to note, however, that iron uptake by roots has been linked to the uptake of other potentially toxic metals such as cadmium and manganese. There is, therefore, a need to understand the regulatory process for iron accumulation in different plant components at different stages of their development before advocating this approach to improve human nutrition.

Finally, the stability of the nutrient in both biofortification and food fortification depends on many different factors. These include pH, oxygen, air, light and temperature, which need to be controlled during processing and storage. Vitamin A and its carotene precursors are unstable when exposed to air and light. And although the β–carotene in Golden Rice is protected during the milling process, its stability during rice storage and in cooking has yet to be published.

Food fortification is an established intervention. For maximum impact, the food vehicle should be centrally processed and eaten on a regular basis, in regular amounts, by the majority of the target population. Additionally, the fortified food needs to be acceptable to consumers, both in terms of its physiochemical and sensory traits, and it has to be accessible and affordable. Food fortification interventions can be highly sustainable if the incremental cost of fortification is less than 2%, and that cost can easily be carried by consumers.

The effectiveness of biofortification is currently unknown. One human efficacy trial compared an undermilled high-iron rice with conventional rice to prove the concept that iron biofortification of rice can improve the iron status of non anaemic women in the Philippines. Proof of concept has also been completed for zinc absorption from low versus high phytate maize in Guatemala. Stable isotopes have been used to determine the bioavailability of β–carotene in Golden Rice, but the results are yet to be published. Without data on stability and bioavailability, it is still unclear whether the current concentration of β–carotene in Golden Rice is sufficient to have a biological impact.

Economic analyses of the potential impact of biofortified varieties on micronutrient status have been carried out using existing food intake data, and they suggest that biofortification of wheat with zinc and rice with iron (and Golden Rice) would be cost-effective in India. However, ex-ante impact analyses include many assumptions about effectiveness, coverage and costs.

For either system to work effectively, permanent monitoring systems of nutrient concentrations must be in place to ensure the required levels in the food or food products as eaten are met and safe. And to succeed, biofortification and food fortification programmes must adhere to national regulations and legislations.

There are other issues, too, around voluntary or mandatory fortification or voluntary or mandatory seed systems for biofortified varieties that will influence programme effectiveness. Whether programmes are financed by the government, the private sector or both, and the level of incentives, will also determine success rates.

Biofortification and food fortification are potentially highly complementary interventions, but neither is a complete solution or silver bullet. As co-ordinated interventions to control micronutrient malnutrition, with input from the nutrition and agriculture sectors, they have the potential to successfully reduce micronutrient malnutrition throughout the world. ■

What does IAASTD mean for us?

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In the on-line debate hosted by the Rural Economy and Land Use Programme (Relu) earlier this year, one farmer responded to the question "What is rural land for?" with "A cynic could say it is for academicians to pontificate about whilst rarely setting foot on it".

Practitioners often feel that research fails to address the real issues. In the 1960s, agricultural science was all about production. Then overproduction and food mountains in the 1980s and 1990s saw farmers become environmental stewards first and food producers second, while we got used to eating imported, all-year-round strawberries. And at the beginning of the new century, it's all change again.

The recently published report of the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) aims to capture research needs across the world in the light of climate change. It is still a controversial topic in the UK, and arguments continue about its causes, but few now deny that changes are occurring and that this has serious implications.

Although we know that developing countries are already suffering, climate change presents our temperate climate with some short term opportunities. Looking further ahead, however, agricultural production is likely to be seriously affected as our summers become drier and winters stormier. We will have to adapt and need science to help us.

Some may wonder whether this will mean abandoning notions of environmental stewardship. That's not being advocated in the IAASTD, which continually refers to the "multifunctionality of agriculture" and emphasises the importance of the environmental dimension. Indeed it does not separate farming and the environmental systems supporting biodiversity, including human life, an interconnectedness we must emphasise in our research strategies.

Land use will have to be multi-functional in future if it is to meet all of our needs. Production must increase to feed the population, but we will also have to tread more lightly in terms of our fossil fuel and water consumption. This trade-off will inevitably pose challenges to science. There are still many uncertainties, and the law of unintended consequences often trips up expectations, as has happened with first generation biofuels. Selling the idea of new generations of crops for fuel will be a difficult task, whatever research tells us about their benefits.

Any development has a human as well as a technological dimension, so there must be investment in interdisciplinary science. Public involvement and open debate need to be the watchwords of research, and the range of stakeholders will have to expand beyond the usual suspects. The IAASTD's emphasis on the "integration of farmer concerns in research priority setting and the design of farmer services", would doubtless warm the heart of the cynical farmer, but will he want to contribute to the costs of such research? Higher commodity prices are driving an argument that says he should, like other industries, invest in his own future.

Public involvement and open debate need to be the watchwords of research, and the range of stakeholders will have to expand beyond the usual suspects

There will still be a role for publicly funded research, which must focus on the wider environmental goods that are vital to our existence, and take a more global perspective. The UK research councils are currently collaborating to launch the Living With Environmental Change (LWEC) programme which aims to connect interdisciplinary research with policy makers, business and the public on a national and international scale.

The plan is for a quality kitemark which will bring much existing research investment under the LWEC brand in a £1 billion package and ensure that the real priorities are addressed. In terms of partnerships, interdisciplinary public engagement and changing behaviour, it is ambitious. Whether it can make even an investment of £1 billion count in this context of uncertainty will be the real test. ■

Animal engineering


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In contrast to GM plants the question of biotechnological approaches to livestock animal reproduction has received comparatively little attention in public, policy or scholarly debate. This may be put down to its perceived distance from commercialisation. However, European commercial approval for the biopharming of GM goats, the US Food and Drug Administration's deliberation over GM salmon, regulatory moves on both sides of the Atlantic over animal cloning and the potential for offspring of cloned animals to enter the food chain, all argue against such inattention.

Proponents of techniques such as genomics and cloning are keen to differentiate these technologies from GM, only too aware of the potential for cultural stigmatisation. This was seen last year with the revelation that the daughter of a cloned cow from the US was being reared in the UK. Media headlines echoed those from the 1990s on GM crops in their tone.

Yet animal biotechnologies can potentially animate cultural anxieties in ways quite different to crops. Even before biotech comes to the table many of us are already ambivalent about animal production, happy to consume but preferring not to dwell on animals' living conditions or experiences.

Whilst some areas of science (ethology, welfare) question the moral hierarchy of a human/animal dualism, others imagine new ways to manipulate and instrumentalise animals. Such contradictions must surely only fuel the ambivalence around human/animal relations in livestock agriculture. Arguably ethics here are better tuned to questioning the hubris of controlling other species, rather than recourse to unexamined ideas of the 'natural' or anxieties over species boundary transgressions.

Many of us are already ambivalent about animal production, happy to consume but preferring not to dwell on animals' living conditions or experiences

Although it may be that in the future some molecular techniques become commercialised while others do not, taken together they point to a growing sense of the geneticisation of livestock animals.

At the same time there are signs that selection goals are becoming less narrowly confined to production traits. Molecular techniques may have a role in correcting previous selection mistakes but it has yet to be seen whether they can perform this task better than existing quantitative genetics. Research on genetic selection increasingly attempts to incorporate animal health, temperament and environmental goals and these are also put forward as potential foci for molecular techniques.

On the one hand this may be seen as a move away from a narrow intensive productivism, yet on the other as a sort of genetic scientism wherein genetics is seen as having all the answers. Animal welfare after all is hardly synonymous with physical health and it is apparent that GM and cloning, in common with the broader history of productivist selection, offer up their own welfare impacts.

For example, there is evidence that cloned animals may have shorter life expectancies, and be more susceptible to some veterinary conditions, than their conventionally-bred cousins, while more widely the Farm Animal Welfare Council's 2004 'Report on the Welfare Implications of Animal Breeding and Breeding Technologies in Commercial Agriculture' points to some of the welfare issues raised by developments in animal breeding technologies.

Although many agricultural scientists working in the field of genomic techniques in livestock breeding envisage a future where animals are produced largely on the basis of knowledge of livestock genetics, currently many farmers who breed livestock challenge that vision. For them, breeding farm animals is something that still relies on a knowledge of their livestock which comes from many years experience, and they frequently argue that their own decisions about what a 'good animal' is contradict what they are told about animals' 'genetic value'. Could molecular techniques then serve to disempower farmers in a similar way as has been argued in the case of crops?

Animal engineering

In an environmental context, the FAO's 2006 report 'Livestock's Long Shadow' brought to increased prominence the contribution of livestock to greenhouse gas emissions and other substantial ecological impacts. Here, also, genetics is being pursued actively to try and improve the environmental efficiency of the animal body. Yet the possibility in this case of genetic scientism, one that effectively blames the animal, is that a broader critical focus upon industrialisation and intensification of agri-food systems, and trends towards over-consumption and more heavily meat- and dairy-based diets, are left unexamined.

It is apparent that GM and cloning, in common with the broader history of productivist selection, offer up their own welfare impacts

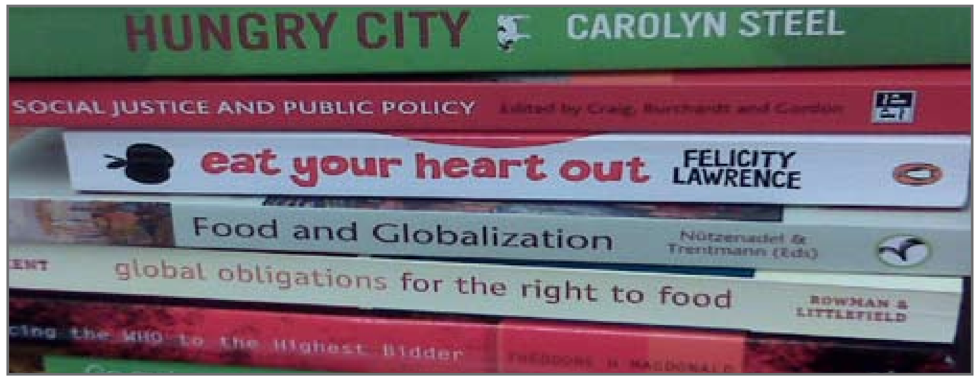
In relation to biodiversity, Defra's 2006 'UK National Action Plan on Farm Animal Genetic Resources' (FAnGR) emphasised on the one hand, that molecular characterisation of livestock could be a valuable technique in cataloguing the genetic diversity of agricultural animals, but on the other that the increasing use of genetic and genomic techniques in breeding livestock, along with the use of AI, presented a significant potential risk to farm animal biodiversity. In this case, a narrowing of the gene pool may foreclose the possibilities presented by a wider genetic base in responding to changing agro-economic and environmental conditions in the future.

Practical and political choices then lie ahead, which will be contextualised by ecological, economic and animal ethics considerations, as well as broader associated struggles over the future of global agriculture.

Given that the UK government wound up the Agriculture and Environment Biotechnology Commission in 2005, renewed political innovation to facilitate engagement on these important issues will be required in the near future. ■

books

reviews



Diet of disaster
Tony Wardle | 2007 | Viva!

Pick any of the most threatening environmental problems and you will find farmed animals at the heart of it. This is the thrust of Tony Wardle's report. Though Wardle delivers a poignant review of the environmental costs of meat production, his conclusion that adopting a vegan diet would cure the ills of the planet is simplistic. HG

Eat your heart out: why the food business is bad for the planet and your health
Felicity Lawrence | 2008 | Penguin

In turns upbeat and pessimistic, Felicity Lawrence leaves no stones unturned in her investigation into who controls the food we eat. From Lampeter in Wales to the Amazon Jungle, via Eastern Europe ,she finds the same global corporations making big money from cheap commodities at the expense of workers' rights, animal welfare and consumer health. EB

Food and globalization: consumption, markets and politics in the modern world
Alexander Nutzenadel and Frank Trentmann (ed.) 2008 | Berg

Taking food as lynchpin of the complex genealogy of globalisation, this book brings together authors from a variety of disciplines. Together they explore the nature and legacies of global food transformations in the modern world. EB

Food matters: towards a strategy for the 21st century
The Strategy Unit | July 2008 | UK Cabinet Office

Dubbed "the most significant piece of government work on the food system since the second world war", by the Guardian's Felicity Lawrence, this is essential reading for anyone with an interest in UK food policy. It is notable for its breadth and ambition, and for its gaps, principally its failure to discuss the obstacles UK trade policies pose to many of government's social and environmental objectives. TM

Global obligations for the right to food
George Kent (ed.) | 2008 | Rowman & Littlefield

Beginning with a plea to recognise that the human right to food should be a global responsibility, not just a local one, Kent and his colleagues look at how international institutions, national governments and individuals can all help to ensure every child born into this world has enough food. EB

Go make a difference: over 500 daily ways to save the planet
Think Books | 2008 | Think Publishing

A comprehensive guide to leading a greener life, this book offers simple, straightforward advice about what to do (and what not to do), to help make a cleaner, greener world. The tips cover every conceivable element of birth, life and death, and there is an informative section on growing, shopping for, cooking, eating and disposing of food. AB

Hungry city: how food shapes our lives
Carolyn Steel | 2008 | Chatto & Windus

Our cheap food is costing us far more than money. Carolyn Steel takes an intriguing and wide-ranging look at the impact modern food production and distribution has had in shaping our cities, our lives and our environment. From the first cities on earth to modern waste disposal, Steel examines how we got here and how to move on. HG

Sacrificing the WHO to the highest bidder
Theodore H Macdonald | 2008 | Radcliffe

A no-holds-barred account of the troubled history of the UN, and its struggle to maintain independence. This book culminates in a powerful call to "buy back the farm" and restore the UN's initial noble purpose. EB

Social justice and public policy: seeking fairness in diverse societies
Gary Craig, Tania Burchardt & David Gordon (eds.) | 2008 | The Policy Press

As the authors of this collection point out, though the rhetoric of social justice is now ubiquitous across the UK political mainstream, that rarely means more than trying to get an 'underclass' into work. This analysis of what theories of social justice should mean in practice has much to offer policies on sustainable development and public health in the food sector. TM

The transition handbook: from oil dependency to local resilience
Rob Hopkins | 2008 | Green Books

Beginning with an explanation of the drivers of the Transition movement, peak oil and climate change, Rob Hopkins takes the reader through all the stages any community, village, town or city should consider upon its path to transition. Complete with handy 'transition tips' and quotes, this inspirational and readable handbook is a must for anyone interested in local resilience and a sustainable future. AB

The slow food story: politics & pleasure
Geoff Andrews | 2008 | Pluto Press

Andrews traces the Slow Food movement from its beginnings in small-town Italy to its current standing as a global, political phenomenon. Throughout, Andrews demonstrates how Slow Food's approach of linking enjoyment of food to environmental protection has relevance to everyday life (and not just for rich foodies) and how adopting this mentality could transform society and culture. AB

eating out

restaurant review

©Tower Inn

Ruth Chadwick is Distinguished Research Professor at Cardiff University and Director of CESAGen, the Centre for Economic and Social Aspects of Genomics. She is a member of the Food Ethics Council.

THE TOWER INN

Slapton, Devon

How I rate it

Overall: *****
Health: ***
Environment: ***
Taste: ****
Ambience: ****
Value for Money: ***

(maximum five stars)

The medieval tower offers an impressive but brooding aspect on the approach to the Tower Inn at the village of Slapton, Devon. The menu at the Tower is varied and deliciously tempting, and there are opportunities to take advantage of local specialities, especially in terms of seafood, so although I was tempted by asparagus and goat's cheese salad, I opted for the seafood chowder. For the main course I chose one of the day's specials on the blackboard - swordfish, with couscous and mixed peppers, beautifully presented with ideal (not over-large) portion size.

What strikes me about eating out these days is how frequently I end up discussing the purported obesity epidemic, metabolic syndrome, and the effectiveness of different kinds of weight-reducing regimes, while in the restaurant. I am not alone in this activity and I am not sure what it shows. Is it that it makes me feel better to show I am at least thinking about these topics while I indulge? Or is there more to it? Perhaps it is an effect of public health campaigns to raise awareness of obesity as an issue and increase a sense of personal responsibility for health. If the latter, however, the policy surely needs to achieve more than affect dinner party conversation if it is to succeed.

In relation to over-eating, it might be assumed that the problem is weakness of will when confronted by temptation, the weakness of will being in relation to choosing rationally and prudentially for one's long term health benefit. It is however, more complicated than that because to some extent and in certain circumstances it can actually be rational to opt for short term pleasure rather than deferred benefit: problems arise when you do that all the time. The difficulty is getting the balance right. The issue is further complicated by overlaying moral disapproval around prudent choices. In another context, when I recently took the short term pleasure option, the person sitting opposite me asked if I always ate so unhealthily, which I interpreted more as disapproval than disinterested concern for my health.

While our relationship with food clearly has a moral dimension, and there are arguments that we have duties towards our bodies, it is difficult to see moral disapproval as a helpful tool in a campaign to reduce the incidence of obesity. Neither, it seems to me, is discussion of the so-called 'fat gene' likely to be helpful here. Even if it made sense to describe genetic influence as 'the fat gene', the appropriate response is unclear and ranges from the fatalistic ("it's not my fault it is in my genes") to the driven "I must try extra hard to counteract this".

At the Tower, three of our party of four ordered the same dessert, gooseberry and elderflower crumble tart, whilst the fourth abstained. Sadly, there was only one portion left and we vied with each other to make the sacrifice. Much easier, it seems, to make a sacrifice so that someone else can enjoy than for the benefit of one's own body shape and health. Individualising eating and stressing one's responsibility for their own body may be less helpful than reinforcing and renewing the social dimension of eating. The social meal is important not only as an occasion to talk about food, among other things, but in relation to the choices we make, and the Tower is a welcoming environment in which to have one. ■

forthcoming events

6th - 7th Sep 08	Soil Association Organic Food Festival 2008 Soil Association | www.soilassociation.org/festival | Bristol, UK
8th Sep 08	Global Warming CIWF | www.ciwf.org | London, UK
11th Sep 08	Food Prices, Food Crisis? The Great Food Debate Brighton & Hove Food Partnership | www.bhfood.org.uk | Brighton, UK
16th - 18th Sep 08	Aquaculture Europe 2008: Resource Management European Aquaculture Society | www.easonline.org | Krakow, Poland
20th - 21st Sep 08	Soil Association Scotland's Organic Food Festival 2008 SA Scotland I www.soilassociationscotland.org/festivalscotland | Glasgow, UK
29th - 30th Sep 08	AgriGenomics World Congress www.selectbiosciences.com | Amsterdam, The Netherlands
1st Oct 08	The World Food Crisis Global Development Forum | www.global-development-forum.org | London, UK
4th Oct 08	Low Carbon Communities Conference LCCN | low.communitycarbon.net | Llangollen, Wales
6th - 7th Oct 08	Healthy Foods European Summit Food & Drink Federation | www.fdf.org.uk/events.aspx | London, UK
14th Oct 08	IGD Convention 2008: the World Turned Upside Down IGD | www.igd.com | London, UK
15th - 17th Oct 08	9th GLOBALGAP Conference: Good Agricultural Practice GlobalGap | www.globalgap.org | Cologne, Germany
16th Oct	World Food Day: World Food Security FAO | www.fao.org | Locations worldwide
21st Oct 08	Making Local Food a Reality: Reaching Urban Consumers South West Rural Update | www.southwestruralupdate.org | Exeter, UK
23rd - 26th Oct 08	Sixth International Conference on Ethics and Environmental Policies: The Lanza Foundation | www.fondazionelanza.it | Padova, Italy
23rd - 27th Oct 08	Salone del Gusto 2008 Slow Food | www.slowfood.com | Turin, Italy
27th - 28th Oct 08	International Conference on Genomics and Society: Reinventing life? ESRC Genomics Network | www.genomicsandsociety.org | London, UK
28th Oct 08	ISAFRUIT Forum: Increasing Fruit Consumption to Improve Health ISAFRUIT project | www.isafruit.org | Brussels, Belgium
28th - 30th Oct 08	The Future of Agriculture: Value or Volume? AgResearch | www.livestockhorizons.com/index.htm | Christchurch, New Zealand
30th Oct 08	Agriculture at a Crossroads (with Professor Bob Watson) UK Food Group | www.ukfg.org.uk | London, UK
4th Nov 08	Health of the Nation: Preventative Health 08 Govnet Communications | www.govnet.co.uk/preventive | London, UK
4th - 9th Nov 08	First European Food Congress European Federation of Food Science and Technology | www.foodcongress.eu | Ljubljana, Slovenia
7th - 9th Nov 08	The Future of Food? Feeding Billions in a Low Carbon World Braziers Park | www.braziers.org.uk | Oxfordshire, UK