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**Can genetically modified crops really help developing countries tackle hunger and malnutrition? Has the technology been hijacked by corporations more concerned with profit than the public good? Here in an exchange of letters *Colin Tudge*, a GM sceptic, and two advocates, *Chris Leaver* and *Anthony Trewavas*, argue their case**

Colin Tudge is visiting research fellow at the Centre for Philosophy of Natural and Social Science at the London School of Economics. His book *So Shall We Reap*, about world agriculture and the role of science within it, will be published by Penguin in September

Christopher Leaver is at the Department of Plant Sciences at the University of Oxford

Anthony Trewavas is at the Institute of Cell and Molecular Biology at the University of Edinburgh

**Dear Christopher and Anthony,**

Some of the nicest people I know in science (and most scientists are nice) are manipulators of DNA - "genetic engineers". Truly, they want to make the world a better place. I have no doubt that if we had anything resembling a sensible strategy for producing food, then genetically modified organisms would find many worthwhile roles. But present-day food strategies are disastrous, and so long as that remains the case then I'm on the side of the saboteurs - plastic spacesuits and all.

The hype behind GM crops is driven by commercial companies. But, alarmingly and disgracefully, it also emanates from politicians such as Britain's Prime Minister, Tony Blair, and from scientists who are not immediately involved yet seem to feel that in advocating GMOs they are defending science against the forces of irrationality. As they stand, GMOs are not a good thing; in fact they are becoming key players in what will surely soon be seen as a global disaster. I am inclined to quote Oliver Cromwell: "I beseech you Gentlemen...think it possible you may be mistaken."

The immediate issue is risk. While even the perpetrators of GMOs acknowledge theoretical dangers - that GM crops could be toxic to consumers and wildlife - the risks, we are told, are small. But the risks are not known to be small: they are not known at all, and in principle they are unknowable. The consequences of dropping exotic genes into genomes, and exotic transformed plants into ecosystems, can hardly begin to be anticipated.

Some moderates urge the precautionary principle: let's make sure we really do have a handle on the dangers before proceeding. But we should invoke a stricter criterion, like the US Food and Drug Administration's principle that new drugs should not be introduced unless they can be shown to have distinct advantages. Do GMOs pass such a test? Blair thinks so. In his speech in London to the Royal Society last May, he implied that the world's growing population cannot be fed without GMOs. Yet this belief,

so common in high places, has nothing to do with the facts.

One statistic makes the point. Today, people ultimately derive half their calories from just three cereals: wheat, rice and maize. All other crops, and livestock too, are marginal by comparison. Blair spoke as if GM were already a world-saver. In fact GMOs have contributed nothing of unequivocal value to the three big crops, and neither are they likely to. That's because the necessary genes - to increase resistance to drought or flood, for example - can be obtained more easily from related grasses, by standard cross-breeding. GM operates almost entirely on the nutritional margins, on peripheral qualities of cereals, and on crops grown for commerce: soya, rapeseed, tomatoes.

Admittedly, we do have "yellow rice", engineered to be rich in carotene, the precursor of vitamin A. Worldwide, 40 million people suffer vitamin A deficiency, which is a major cause of blindness. Yet carotene is the pigment in yellow fruits such as papaya and in dark green leaves such as spinach. Horticulture can give us all the carotene we need. The trouble starts only when societies are persuaded to give up traditional, mixed farming in favour of modern monoculture.

In short, GM is not about feeding people. It is about commerce. Its advocates do not occupy the moral high ground. They believe they do, but only because they have not looked carefully at the evidence.

Agriculture is the most important of all human activities. If we get it right, everything else can follow: well-fed people in peaceful communities, abundant and secure wildlife. If we get it wrong, all the world is in trouble. Clearly, we are getting it wrong. While some people still starve, more and more are overfed, and rural societies and wildlife worldwide are wrecked. The root cause is that agriculture is not designed to feed people. It is perceived, in the chill modern phrase, as "a business like any other". This is a perversion.

Humanity needs agriculture that is designed to feed people. In achieving this, science has many essential roles. But we have to get the strategy - social, ecological, nutritional - right first. Only then can we ask what science, including GM, can really contribute. At present, all human endeavour, including farming, is squeezed through the channels of global commerce, and science has become its handmaiden. This is a tragedy for agriculture, for science and so for humanity. I hope the scientists wake up soon.

**Dear Colin,**

"We've never done this before, so let's not risk it; and if it does work, a lot of people we don't like are going to make money out of it." This is how the columnist A. A. Gill summarised objections to GM in the London *Sunday Times*.

Such sentiments are clearly irrational, and it is equally clear that we cannot give in to them. You and other critics of GM crops cannot escape the fact that nearly six million farmers, more than 75 per cent of whom are in developing countries, have chosen to grow them, and that they now cover 58.7 million hectares in 16 countries. Why have these farmers made this choice? Quite simply, GM crops deliver real, sustainable benefits for agriculture, human health and the environment by reducing pesticide use and increasing yields. A recent study estimates that if half the farmers in the European Union started to grow GM varieties of four crops - maize, oilseed rape, sugar beet and cotton - annual pesticide use on those crops could be reduced by 40 per cent, with additional savings of 20 million litres of tractor fuel and a corresponding decrease in carbon dioxide emissions of 73,000 tonnes (*Journal of Animal and Feed Sciences*, vol 11, p 1).

Your first objection centres on the risks that GM crops pose, and the difficulty of measuring such risk. Yet all of us have eaten genetically modified food all our lives. Conventional plant

breeding uses many natural mutants - this is natural genetic engineering. If we replicate by genetic engineering what nature has already done, are we really doing anything different?

As the US Society of Toxicology points out: "It is the food product itself rather than the process by which it is made that should be the focus of attention in addressing safety." GM crop plants are rigorously tested according to internationally harmonised standards, making them even safer than conventional plants and foods. To date no one has reported being harmed by eating GM food, despite the fact that hundreds of millions of people have been eating it for nearly a decade.

Consider the GM farm trials currently taking place in Britain. They involve maize, fodder beet for use in cattle feed, and oilseed rape that produces oil chemically identical to its non-GM counterpart. The main traits these GM varieties display are resistance to herbicides or pests. The advantages are clear: pest-resistant crops require less pesticide. And conventional breeding has produced only three herbicide-tolerant crops.

The oft-repeated concern of the sceptics is that herbicide-tolerant GM rape or beet might generate superweeds through introgression (natural gene transfer) with a few related weeds. But since conventional crops with an identical genetic trait manage to avoid this fate, we have no need to fear it happening with GM varieties. Rather than superweeds, introgression produces wimps that fall easily to the plough and are unable to survive outside the farm environment.

You fail to mention the benefits that GM crops have brought the world over. A million of the poorest Chinese farmers, whose farms average 1 hectare, have seen their incomes increase 25 per cent annually through the use of government-produced GM pest-resistant cotton that requires them to spend less on pesticides. It has also led to a reduction in cases of pesticide poisoning from potent organophosphates and carbamates. In India, farmers broke down doors to get GM pest-resistant cotton seed after five years of severe bollworm infestation.

There is much more that GM crops could do for poor people. In Mozambique, a serious epidemic of brown streak virus is destroying cassava crops. When harvests fail here, people die. It should take only a few years to develop a GM virus-resistant cassava. Using conventional techniques it would take a lot longer. Starving children cannot wait.

Over the next 50 years, the global population is set to increase by 3 billion, and possibly by as much as 4.5 billion. To feed the world, cereal production will need to increase by between 35 and 100 per cent, and meat production by over 55 per cent over the next 20 years. For inspiration about how to deal with this, we turn to a surprising source: yourself. In 1988 you wrote in your book *Food Crops for the Future* (Blackwell): "The prize if we care to exert our new-found power is very great indeed: a stable and attractive world capable of indefinite survival...We could provide enough food even for 10 billion people who will probably be on Earth by the middle of the 21st century. Good science well applied does have a great deal to offer. The world could be fed."

**Dear Christopher and Anthony,**

I have spoken to many farmers in five continents over the past 20 years and "choice" for them increasingly means doing what the processors or retailers tell them to, or going bust. "Hobson's choice", I think this is called. Of course there are papers that show GMOs in a good light, but the case is not made by listing them. Other studies reveal disadvantages.

More to the point, the literature as a whole urgently needs review - not only its content, but also its provenance. Many scientists are alarmed that so much food and farming research is now financed by industry. It is clearly easier to publish results that support the

industry line. Anecdotally, I know farmers in the US (names on request) who have found GMOs to be highly equivocal. Among other things, they find they need exotic herbicides to remove the remnants of last year's herbicide-resistant crop.

The point that genetic engineering merely extends conventional breeding is often mooted but it will not do. GM and other biotechnologies, notably cloning, take us into the age of the "designer" organism. Both were solemnly declared to be "biologically impossible" until about 10 years before they became reality. Nowadays, nothing that does not break the laws of physics can be considered biologically impossible. Only the laws we make ourselves, and our own morality, can hold us back. If people in high places cannot see that this is a qualitative shift, requiring a new mandate, then they should not be in charge of political strategy.

As you kindly acknowledge in quoting my 1988 book, I and other serious critics are not against GMOs per se. If the world had a serious strategy for feeding people, which we might reasonably suppose is what agriculture is for, then GMOs could play many important roles within it. But the present policy is to industrialise, corporatise, globalise and effectively hope for the best. It's a strategy that is already proving disastrous, and could prove terminally so.

**Dear Colin,**

We are making progress. You have come off the fence and begun to distinguish science from politics.

Scientists have recognised for some time that the GM debate is really about values, feelings and beliefs. Objections supposedly based on science are used to bolster political ideology. Some sceptics have described GM technology and its enthusiasts as "dangerous". But is it more dangerous for independent university scientists to defend a technology of proven value to developing countries, or for GM opponents to risk the lives of starving people by suggesting that GM food causes cancer or generates dangerous viruses?

Conventional crop breeding has in its own way designed crops for human benefit by modifying plant architecture, pest resistance, composition, seed structure, size and nutritional value. It is not known how radical the genetic changes that enabled such progress were, because in molecular terms conventional plant breeding is still a black box. But assumptions that such genetic changes were minor and that GM will be more radical are unwarranted.

The speed of uptake of GM crops by farmers from developed and developing countries says it all. Indeed, as you acknowledge, GMOs could play many important roles. It seems that behind the rhetoric, your main concern is what you perceive as the lack of a serious global strategy for feeding people.

In this context, and to paraphrase what you say at the end of your first letter, it is not the scientists who need to wake up; it is those who use science to frighten people and governments. That is not the fault of commerce. The biggest threat today to people in developing countries is not GM, it is starvation. We accept that GM technology alone will neither feed the world nor eliminate poverty, but action is needed now to address these challenges. We must combine the best of conventional plant breeding and agricultural practice with the new biotechnologies to develop a sustainable and environmentally friendly agriculture.

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