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*GM crops are unsound and unsafe; the biotech corporations are still making promises that they cannot keep while their real aim is to tighten their stranglehold on seeds to starve the world.* [Prof. Peter Saunders](#)

Conventional agriculture is not the answer, neither is GM

"In agriculture, the starting point, I think, has to be the recognition that the commercial industrial technologies that are used in agriculture today to feed the world are technologies that are not inherently sustainable and they have not worked well to promote either self-sufficiency or food security in developing countries." Most people would be surprised to learn that these are the words of Robert Shapiro, then the CEO of Monsanto [1]:

And earlier [2]: "Loss of topsoil, salinity of soil as a result of irrigation and ultimate reliance on petrochemicals [which are] obviously not renewable. That clearly isn't sustainable."

This is the sort of statements you'd expect to come from a campaigning group rather than a big corporation. It's a solid condemnation of the Green Revolution and a warning that the current attempt to extend it to Africa is misguided. Of course Shapiro was pushing what he saw as the alternative to industrial agriculture, namely genetically modified organisms (GMOs) for crops and livestock.

In fact, the evidence shows that the answer lies neither in conventional industrial agriculture nor in GMOs, but in organic agriculture. The 400 scientists who contributed to the recent report of the International Assessment of Agricultural Science and Technology for Development (IAASTD) certainly did not see GM as the answer to the food problem. On the contrary, they concluded it could have at most a relatively minor role [3, 4] ("[GM-Free Organic Agriculture to Feed the World](#)", *SiS* 38).

The truth about genetic engineering is that it has consistently failed to deliver. It has not increased yields [5]: for example, researchers at the Universities of Kansas in the United States found that the yields of GM soya were about 6 per cent lower than those of their nearest conventional relatives [6], confirming results obtained since 2002 [7] ("[GM Crops Failed](#)", *SiS* 13/14). It has not decreased the amount of herbicides and pesticides used. Since Roundup Ready crops have been widely grown in the USA, glyphosate application on major crops has gone up by a factor of 15 [8]. That has not been merely a matter of farmers switching to Roundup (Monsanto's proprietary formulation of glyphosate); the application of other herbicides has also gone up. And it has not increased the profits of farmers: for example, a study has shown that farmers in the American state of Georgia who grew Bt cotton did not make more money than those who did not [9, 10] ("[Transgenic Cotton Offers No Advantage](#)", *SiS* 38) and the mass suicides of cotton growers in India are all too well known (see [GM is Dangerous and Futile](#) [11], *SiS* 40).

The only group that have gained from GM are the biotech companies.

The supporters of GM continue to make extravagant claims for what it can accomplish, and you can easily be taken in if you do not look carefully at the evidence. For example, in the abstract of a recent paper in *Science* [12] the authors write: "Our data suggest that Bt cotton not only controls *H. armigera* on transgenic cotton designed to resist this pest but also may reduce its presence on other host crops and may decrease the need for insecticide sprays in general."

The abstract is all you can read for free on the web, and it is what most commentators are likely to quote, especially if they are supporters of GM. In the full paper, however, the authors report that mirids, podsucking bugs that used to be controlled by spraying and by competition with the bollworm, have now become key pests of cotton in China. They conclude their paper with the statement: "Therefore, despite its value, Bt cotton should be considered only one component in the overall management of insect pests in the diversified cropping systems common throughout China." That's not at all what you would infer from the abstract.

Do they really believe what they say?

How far do the biotech people themselves really believe the claims they make in public? In their more thoughtful moments, some of them talk quite differently.

*Nature Biotechnology* is more or less the house journal of the biotech industry, and regular readers of *SiS* will know that we and others have criticised them twice within the past year for blatant bias in favour of GM [13-16] ("[Letter to Nature Biotechnology: Systematic bias in favour of no adverse impacts from GM feed](#)", [Letter to Nature Biotechnology: Prepublication Review Yes, But Review Panel](#)



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[Must be Balanced](#), and From the Editors, [Science in Society 37](#)). Even so, here are extracts from an editorial that appeared a couple of months ago [17].

The Biotechnology Industry Organization's (BIO) slogan for its annual meeting held in San Diego in June was 'Heal, fuel, feed the world.'

On no count is this equivocal or faltering or modest. Of course, perhaps that should be expected of an industry lobby organization whose job it is to proselytize the potential of its members' technology and products. But the problem is the slogan just isn't very realistic.

"There are hundreds of thousands of acres of genetically modified (GM) crops being grown around the world, but they are not at present addressing key agricultural problems for poor farmers, such as salinity, desertification and drought. Nor are they addressing problems such as malnutrition (although with Golden Rice, they could)."

(Actually, Golden Rice can't contribute to the problem of malnutrition because it can't supply anything like the required amount of  $\beta$ -carotene and what there is won't be converted to vitamin A if you are undernourished [18] (['Golden Rice' - an exercise in how not to do science](#), TWN/ISIS publication), but let's go on.)

And although biotech has addressed a few orphan diseases, produced new therapies in infectious disease, cancer and autoimmune disorders, and recombinant versions of biologics for diabetes and growth disorders, it hasn't delivered on the promised 'cures' of genetic therapies or even the wide adoption of molecularly targeted medicine. Certainly, it hasn't done much to address disease and malnutrition among the world's poor.

"This journal champions biotech research, so we are not downbeat on its prospects to, one day, generate products that will heal, fuel and feed the world. That is, nevertheless, *an outrageous act of faith bordering on the religious.*" [emphasis supplied]

All that from a committed supporter of GM!

### What can GM do?

In September 2008, the British government announced that it was going to change its policy and allow GM crops to be grown in the UK. The then science minister, Ian Pearson, explained that the world needs GM because "we can grow drought resistant crops". (And as we have just learned from environment editor Geoffrey Lean of the *Independent on Sunday* [19], that was part of a secret plan instigated by the pro-GM president of the European Commission José Manuel Barroso with the UK and 26 other European governments to spread GM crops in Europe.)

Except that we can't make drought resistant crops by GM. Even the editor of *Nature Biotechnology* admits we can't. What the minister should have said was "The biotech companies have promised us that at some unspecified time in the future they will produce drought resistant crops by some method that they haven't yet developed, and that is why in the present we are going to allow them to grow Bt maize in the UK even though we don't need it and the consumers have made it abundantly clear that they don't want it."

There's a gap in the logic there, and an even more important gap in the science. In the first place, contrary to what is often stated, genes don't make traits like higher yields, drought-resistance, or being perennial instead of annual, or even, make women want to marry older men and men want to marry younger women [20]. (No, I didn't make the last one up. It's one of the classic claims of so-called evolutionary psychology). What genes do is to code for the production of proteins. The traits we observe, what biologists call the phenotype, as distinct from the genotype, arise through the complex interactions of these gene products with other gene products and with the environment.

Secondly, while most people think of a gene as a piece of DNA, that is at best a vast oversimplification. Not only do genes come in many separate pieces, the pieces don't even all have to be on the same chromosome. The same piece of DNA can be part of two genes at the same time. And there are other complications as well. The situation is so complicated that modern molecular biologists define a gene by what it *does* rather than by what it *is*. [21] (see also [11]).


Now in genetic engineering, what we do is to cut out or copy a piece of DNA from one genome, or take an entirely synthetic piece of DNA, and insert that into a DNA molecule in another genome. But whatever a gene is, it is not a single stretch of DNA, so what is being transferred cannot be a gene. Add on to this the fact that most traits are determined by more than one gene, and there is little reason to suppose that genetic engineering can work at all, save for the simplest characteristics, such as insect resistance or herbicide tolerance, which is practically all we have now.

*We certainly cannot just choose any trait we want and use genetic engineering to make a crop that has it.* Stan Cox has described how he and his colleagues at the Land Institute in Salina, Kansas, are using the traditional techniques of selection and hybridisation to produce perennial grain crops [22] ([Ending 10 000 Years of Conflict between Agriculture and Nature](#), *SiS* 39). This may strike you as a bit old fashioned, and you may have wondered why they do not simply transfer the gene for being perennial to the crop plant, or the gene for high yield to the perennial. The answer, as Cox pointed out, is that there are no such genes. For example, for sorghum, originally a tropical plant, to be perennial in a temperate climate depends on genetic material on 9 of the plant's 10 chromosome pairs. Transferring such a trait by genetic engineering is clearly impossible.

So if we want perennial crop plants that yield as well as their annual counterparts, it looks like we're going to have to do it by the sort of breeding that's been known for centuries. The same is true for most traits, including almost all of those we would really like our crops to possess.

### GM hazards to health

We should not lose sight of the fact that there are serious health hazards associated with GM crops

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[11], which would be a reason for rejecting them even if they performed better than conventional crops, and they do not.

The biotech industry is fond of saying there is no evidence that any humans have been harmed by eating GM food. In the first place, that's because they've very carefully not looked for evidence and have ignored all the reports of real incidents. They have also worded their usual statement very carefully to make it sound much stronger than it is. *Eating* GM food is not the only exposure that can be harmful, as in the Philippines and in India, where villagers and farmers exposed to Bt maize pollen and Bt cotton suffer allergy-like symptoms since 2005 [23, 24] ([GM Ban Long Overdue](#), *SiS* 29; [More Illnesses Linked to Bt Crops](#), *SiS* 30), and this is continuing in India to the present day [25] (see Save Farmer Movement for the latest news, <http://www.kisanbachaoandolan.co.cc/>).

There is ample evidence that *animals* have been harmed by GM feed in laboratory experiments [11]; from the findings of Arpad Pusztai and colleagues on rats fed GM potatoes, of Irina Ermakova on the offspring of rats fed GM soya, of researchers at the CSIRO in Australia on mice exposed to transgenic pea containing a gene from a bean, which you would have thought would be relatively safe because the two plants are closely related, but the transgenic pea made the mice seriously ill. Then farmers have witnessed cows in Germany that died after being fed on Bt maize; and sheep, goats, cows and other livestock in India that fall ill and died after grazing on Bt cotton crop residues or even cotton seed cakes [25].

Whether humans have been harmed by actually eating GM food is hard to tell because there is no labelling in countries like the USA where people are most likely to be eating GM food (though most of it has probably gone into animal feed after processing). Also, the effect may take time, just as the effects of smoking and asbestos do.

We do know, however, that serious allergies are much more common now than they used to be, and we also know that humans and animals can get allergic reactions to GM food and pollen, which is not surprising as new molecules are involved. That doesn't prove GM was the cause, but there's certainly no justification for claiming that it wasn't.

## GM hazards to the environment

Contrary to what Shapiro claimed, GM crops are no better than conventional agriculture in their effect on the environment, and in most cases worse: more pesticides and herbicides used after just a few years [8], less biodiversity [11], secondary pests explode as the targeted primary pest becomes diminished [12], or worse, become resistant to the pesticide; and herbicide resistant superweeds [11]. Just like conventional crops only more so, GM crops degrade the soil because of the heavy use of herbicides and pesticides and because of their reliance on chemical fertilisers. They also contaminate other crops by of cross pollination [26] ([GM Contamination At 21 km and Farther. No Co-Existence Possible](#), *SiS* 35) or by horizontal gene transfer between unrelated species, especially via bacteria in the soil [27] ([Horizontal Gene Transfer from GMOs Does Happen](#), *SiS* 38).

The biotech industry and the regulators sometimes claim that a separation of only a few metres between GM and conventional fields is enough to prevent contamination. This is patently not the case, as confirmed by the most recent large scale study carried out by scientists at the US Environment Protection Agency, showing contamination at 21 km away [26]. In large areas of Canada there is no longer any GM-free canola [28]. ([Do Not Let our Nightmare Become Yours. Warn Canadian Farmers](#), *SiS* 17); The herbicide resistance has also spread to weeds [11]. So after a few years of whatever gain there is from growing Roundup Ready crops, the farmer is likely to be worse off than before. And it is not just the farmers who choose to plant GM seed that will have the problem. *All* farmers will have to cope with GM superweeds.

## Monopoly on food

The only party that have profited from GM are the biotech companies. Some supporters of GM will even admit to that, though they immediately go on to say that in the future we will all gain, clearly a case of pie in the sky.

The reason biotech companies are so keen on GM crops is because they are patentable, unlike ordinary crops. If you breed seeds by conventional methods, you can only get "breeder's rights". Exactly what that entitles you to varies a bit from country to country, but essentially it means that no one else can market seeds of that variety until the rights expire. Farmers are, however, specifically permitted to save seeds for their own use. In complete contrast, because GM varieties can be patented, the biotech companies can and do prevent farmers from saving the seeds, as Canadian farmer Percy Schmeiser discovered.[29] ([Schmeiser's Battle for the Seed](#), *SiS* 19).

The big seed companies are buying up the smaller ones, and Monsanto has been particularly aggressive in acquiring seed companies in recent years. It controls more than 90 percent of the market in many important crop seeds, and Iowa attorney general Tom Miller has been investigating the company to determine if it violates antitrust laws.[30]. As the company controls more and more of the market, it makes non-GM seeds harder and harder to get, and it won't make any attempt to improve those that remain. It is able to raise prices to whatever level it likes, and farmers are already paying higher seed prices with less choice in the marketplace. If nothing is done to combat this, every farmer in the world will have to buy seeds every year from one of half a dozen or fewer corporations that will thus have a complete stranglehold on the world's food supply.

That's bad enough in the USA, but in the third world, where farmers are typically close to the margins, it is disastrous. If farmers have to borrow money to buy seeds they stand to lose their farms if the harvest is not what they were promised. Thousands of suicides in India have been blamed on GM cotton. The only thing that saves them is to switch back to growing organic with their traditional varieties [31] ([Message from Andra Pradesh:Return to organic cotton & avoid the Bt cotton trap](#), *SiS* 29), the seeds of which they can save from year to year and get a bumper harvest without fertilizers and pesticides to get them into a cycle of debt..

## Conclusion

The evidence is clear: industrial agriculture is out; GM agriculture is worse and unsafe. Organic agriculture, on the other hand, *can* feed the world, and feed it well, as Catherine Badgley and colleagues in the University of Michigan have shown by a careful analysis of data already published [32], and as many other studies have confirmed in ISIS' own report [33] ([Food Futures Now \\*Organic \\*Sustainable \\*Fossil Fuel Free](#)). [Especially relevant is the project](#) carried out by Sue Edwards and colleagues at the Ethiopian Institute of Sustainable Development in Tigray over a period of seven years, documenting how compost produced yields 30 per cent greater than chemical fertilisers. (Not surprisingly, crops treated with chemical fertiliser did better than those that were not treated at all, so if this had been a Green Revolution project it would be claimed as a great triumph for chemicals.)

A couple of years ago, some ordinary rice in the USA became contaminated with GM rice that was being trialled. This was not picked up by the Americans, which shows how feeble their testing is, but was noticed in Europe. The authorities were slow to act, the UK worst of all [34] ([GM Rice Contamination How Regulators Tried to Sidestep the Law](#), *SiS* 32), but the consumers would not tolerate it. You can see just how strongly they objected from a packet of rice found in a London greengrocer. The original label described the contents as "American Long Grain Rice", but this apparently referred to the variety of rice, not its origin. So the distributor had covered it with a new label, informing the consumer that this was "Long Grain (Non USA Origin): Please Ignore All References to the USA".

Can GM be stopped? Yes, it can, if consumers refuse to buy it and if farmers refuse to grow it. That little package of rice reminds you what can happen when consumers will not buy something they don't trust and don't want. And if consumers don't want to buy GM, farmers have even less reason to grow it. Among the strongest critics of the lax US regulation and quality control that allowed contaminated rice to be exported were American rice farmers who saw their overseas markets disappear.

And when governments and industry give up devoting so much time, effort and resource to what even the IAASTD considers to be a side issue as far as feeding the world is concerned, we will be able to concentrate on measures that will really make a difference.

*This article is based on lectures delivered at the International Conference on Climate Change, GMOs and Food Security, held on 1-2 October, 2008, in New Delhi, India, and the Forum on Genetically Modified Organisms: "Have GMOs Delivered?" held on 16 October 2008 in Manila, Philippines.*

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