

## **The vexed issue of GM food – a journalists' journey.**

In 2007, I wrote a feature story for Cosmos magazine titled “Organic Food Exposed”. It explored two-questions: Was eating organic food healthier for us? Was growing it healthier for the planet?

My conclusion was “NO” on both counts. Rick Roush was one of the people I interviewed in the course of researching the story. Rick was clearly interested in the subject matter but he was also very interested in the process by which I put the story together. So earlier this year, he invited me to lay bare my workings for the purposes of this lecture.

I decided I would move on from organic food to focus on the debate over GM food. Both because it is timely with the lifting of the moratorium on GM Canola in Victoria and NSW last November and because it is relevant to a book I am writing which is looking at the impact of modern genetics on our lives.

### **Slide 1: A scientifically literate Lois Lane:**

So who am I? I am a scientifically literate Lois Lane. I did a PhD in biochemistry at the University of Melbourne and then five years of post-doctoral research at the University of California in San Francisco. That research looked at how genes direct the transformation of a mushy fly egg into an embryo. It turns out the same genes are at work in the sculpture of every animal embryo. My years of scientific training equipped me with the basic vocabulary of genetics and biochemistry, gave me research skills, and drilled scientific rigour into me. This is, you approach everything very sceptically—you look for the flaws in the conclusion. The last twenty years of being a journalist has made good use of those skills.

### **Slide2: Judge in courtroom**

GM food is one of those curly debates that seem to pit experts against each other. My role is like that of a judge in the courtroom – to try to help the public weigh the evidence. How do I weigh evidence? As a starting point, I give evidence different weight depending on who it comes from. I'll certainly read the literature from activists, companies or think tanks but I give it a lower weighting than information I get from academic scientists. The strongest weighting goes to publications in refereed scientific journals, and here the ranking of the journal makes a difference. I give more weight to something I read in Nature or Science than in the Journal of Alternative Agriculture.

It becomes very difficult when scientists publishing in respectable journals disagree with each other. But it's certainly not unusual – think of climate change or cloning. Many of the stories I have written centred on a scientific duel – after all controversy is a great trigger for a story. Weighing the evidence of dueling scientists is an eternal challenge. Opposing views often both have merit. On the other hand the views of some scientists can be compromised by their personal agendas or just plain ineptitude.

The best working guideline is to take the majority view. Which is not to say that the majority view is always right. Mavericks have sometimes been famously right: think of Australian Nobel prize winner Barry Marshal who bucked the establishment with his view that ulcers were caused by a bacterial infection rather than stress. However in the fullness of time, the maverick view will win the majority over if it can be proven correct. As a working rule then, the best evidence one can muster at the time is usually the majority view.

### **Slide 3: Scales of justice**

So members of the audience, today you are the jury for a trial on GM food. And I will try to weigh the evidence for you.

### **Slide 4: Summing-up**

But I won't keep you in suspense. I'll give you my sum – up first.

It's truly alarming that at a time when we all need to be thinking sustainably, the public is championing the least sustainable agricultural method on the planet – organic farming – and demonizing the most sustainable methods; which involve as one their key tools, GM crops. (Organic farming might feed at most four billion people and would need to grow all the fertiliser that's currently being made chemically. Where will all that extra land come from to grow manure? Most of the land available for farming is already under cultivation.)

### **Slides 5, 6:**

Farmers have been pleading with the public for years but somehow we've blithely dismissed the economic benefits to farmers that come with superior pest and herbicide control. We, as consumers, couldn't see the benefits to us. Now all that's changed. For the first time in decades there is a global food shortage. According to the US Department of Agriculture, global food supplies have plummeted from 115 days in 2000, to a projected 56.7 days. It followed crop failures in Australia (due to drought), in Asia (due to cyclones) and the diversion of food grains to biofuels. The US Food and Agriculture Organization (FAO), say the shortage is not going away any time soon. In Australia, we feel the pinch to our pockets; in Haiti, Africa and Asia, people starve. For the first time in decades, the availability of food is controlling the price.

The reality is it's just a taste of things to come. We need to grow more food for the 2.3 billion extra people who are coming by 2040. But we've used up our fertile land. Water is running out, soils are getting saline, biofuels are competing with food crops. In a nutshell, we need to grow more food with fewer inputs. To do that we need the best tools we can get. GM crops are a powerful tool that we cannot afford to be throwing away based on ill-informed decisions about health and sustainability.

So what are Genetically Modified crops?

### **Slide 7: Traditional Breeding is genetic modification on a grand scale**

We have genetically modified everything we eat. The traditional way of doing it is crossing plants. The wimpy plant on the left is Teosinte – the Mexican ancestor of corn. It is a single row of encased seed. To get from Teosinte to modern corn took thousands of years of crossing to get just the right set of genes together. The breeder is beholden to chance, trial and error.

With GM, you control the process. And you're not limited any longer to genes that only come from corn. Because the genetic code is universal, a gene from bacteria can be read by a plant: it's just a matter of engineering it into the plant so that it slots in next to the other 90,000 or so other genes.

### **Slide 8: Genetic Engineering Techniques**

To genetically engineer a novel gene or so-called “transgene” into a plant, two methods are used. One involves a bacterium known as Agrobacterium. Besides its regular chromosome, it possesses a smaller module of DNA that acts like a cassette – it is able to insert itself into the chromosomes of a plant. Genetic engineers take advantage of this natural gene ferry.

They insert the transgene as a passenger. When the bacterium infects plants cells, the transgene slips into the plant chromosome. To track the movement of the transgene, the scientists usually attach an antibiotic resistance gene to it. If the plant cells are resistant to antibiotics, it means that they have acquired the transgene. The plant cells are then grown into a GM plant. An alternative way to get transgenes into a plant chromosome is to coat gold particles with the gene and shoot them into the cell. Some of these genes end up being taken into the chromosome.

### **Slide 9: BT Cotton**

BT cotton is a GM crop, where the transgene comes from the bacterium *Bacillus Thuringiensis*. The bacteria naturally produce this protein that is toxic to insects if they eat it because it perforates the insect gut. Farmers, including organic farmers, spray BT preparations on plants as an insecticide. But it requires multiple applications because the BT protein degrades within a few days. Being a protein, BT was amenable to genetic engineering. The insertion of the bacterial gene for BT would instruct the plant to make its own BT protein. Researchers reasoned that inbuilt protection would provide superior protection for the plant, while reducing the farmer's need to spray.

### **Slide 10: Benefits of BT cotton**

This table is from a paper in Science magazine in 2002 and calculates the benefits of using BT cotton for Chinese farmers. BT cotton produced a higher yield, but it also reduced the amount of spraying the farmers had to do by 80%. That led to a total cost benefit of \$334 million in one year. The farmers' health benefited too. Because they reduced their exposure to toxic pesticides like organophosphates and organochlorines by 80%, the incidence of poisonings also dropped by 80%. Since 2002, BT cotton has been grown in India with similar benefits. Cotton production has doubled and the amount of pesticide use has been decreased.

### **Slide 11: Just some groups of non-target arthropods not harmed by Bt crops**

Nature has been very provident with the Bt toxin. Different strains of bacteria make toxins that are only toxic to particular groups of insects. This slide from entomologist Rick Roush, shows insects that are not affected by Bt crops. There was a 1999 report from Cornell University that pollen from Bt maize poisoned Monarch butterflies. But this was a laboratory experiment using maize strains with very high levels of Bt in their pollen. Commercially grown varieties had low levels of Bt in their pollen. In 2001, six follow up studies reached a consensus that there was no cause for concern. <http://www.ars.usda.gov/is/br/btcorn/>

### **Slide 12: GM Canola**

GM Canola has been making the headlines since last November when the Victorian government lifted the moratorium on the growing of this crop. The moratorium was applied in 2004 because it was believed that maintaining Victoria's status as "GM free" would earn it a premium in overseas markets. Based on Gus Nossal's review last October, however it turns out Victoria is economically worse off by not growing GM Canola, so that led to the end of the moratorium. According to the analyst company ACIL Tasman, Victoria stands to save \$115 million over 8 years by changing over to GM Canola.

GM Canola carries a transgene for herbicide resistance. This is especially valuable in canola because there are no herbicides to selectively kill of its weeds, wild radish and wild mustard. So the answer is to give the plant an edge against a broad spectrum herbicide, and spray the whole crop with it. Till now Victorian farmers have used herbicide resistant canola produced by breeding. This canola was resistant to the herbicide Triazine. GM canola is resistant to

the herbicide glyphosate aka Round Up. Glyphosate interferes with an enzyme (EPSPS) that the plant needs to make amino acids. But a strain of agrobacterium has a resistant version of this enzyme. By transferring this bacterial gene into the canola, the plant gains the same resistance to glyphosate as the bacteria. So the farmer can spray glyphosate on the crop but only kill the weeds. The farmer ends up winning because the GM crop yield is higher. Environmentally this is a winner too because Glyphosate ends up replacing Triazine which is considered to have higher toxicity.

Another environmental win for GM Canola is that it facilitates “no till” farming.

### **Slide 13: No till farming = sustainability**

Ploughing may be the icon of farming but it destroys the soil structure and leads to erosion. Soil erosion is the number 1 issue for sustainable farming. It can take a thousand years to make an inch of topsoil; ploughing can erode it in a few decades. There's a connection between soil erosion and the decline of ancient civilizations. Think of the dustbowls of Kansas and the dust storms seen in Australia in decades past.

Ploughing is used to destroy weeds, turn over the stubble, and work in manures. But “no till” farming does away with ploughing. Instead it relies on herbicides to control weeds, and machinery that injects seed directly into the stubble. Studies show enormous savings of soil, 90-98% compared to conventional ploughing. Compared to organic methods which rely on tillage to work in the manures, no till farming saves about 80% more soil.

<http://www.ars.usda.gov/SP2UserFiles/Place/12650400/FSP%20Research%20Summaries.pdf>

No till farming also saves the farmer the costs and the fuel of ploughing. And it turns out that not turning the soil keeps more carbon in the ground. PG Economics claims that the overall carbon saving of no-till farming is equal to taking 20% of the cars in the UK off the road.

### **Slide 14: Benefits of BT maize –(picture courtesy of David Tribe)**

In his right hand, the African farmer is carrying damaged non-GM maize; the culprit is the corn stalk borer. In his left hand, he holds the intact GM variety which is protected by carrying its own BT gene. Studies show that BT maize produces a yield increase from 5-40%.

### **Slide 15: BT Corn can be vastly healthier**

But there's another major benefit from growing BT maize. During storage over the African winter, it is less prone to being infested with moulds. Food moulds produce some of the most potent toxins around, like: aflatoxin and fumonisins that cause cancer in people and cattle. These moulds tend to take hold when the corn grain has been chewed at. Because BT corn is less damaged it provides fewer niches for the mould. Studies show 40 fold lower concentrations of mould toxins with storage.

### **Slide 16: Economic benefits of GM**

Several recent studies have calculated major economic benefits to farmers from growing GM crops because of increased yields and decreased inputs.

1.PG Economics: UK –based consultancy for agriculture: economic benefits at the farm level, \$7 billion in 2006

2. ABARE 12 May 2008 : economic benefits for four states: NSW/WA/SA/Vic over next ten years: \$728 million

3. Nossal Report for Victorian Government October, 2007 (Review of moratorium placed in May 2004): lifting ban on GM Canola would generate up to \$115 million for the Victorian economy over the next eight years.

4. In Canada, where about 85% Canola is GM, yields increased by 27% since 1996. In Australia it fell by 10%. See Norton and Roush, 2007, <http://uninews.unimelb.edu.au/news/4752/>

### **Slide 17: Benefits to the environment and the developing countries**

In its most recent report PG economics UK, calculated the following benefits of GM crops to the environment and farmers in developing countries.

[http://www.pgeconomics.co.uk/gm\\_crop\\_economic\\_environmental\\_impact.htm](http://www.pgeconomics.co.uk/gm_crop_economic_environmental_impact.htm)

- Greenhouse gases reduction equal to 6.6 million cars (because of reduced fuel use and lo-till capture of carbon in soil)
- Biotech crops have reduced pesticide spraying by 286 million kg
- Farmers in developing countries obtained the largest share of the farm income gains in 2006 (54%)
- World price levels of crops like corn and soybeans would probably be higher than the current (record high) levels if this technology had not been widely adopted by farmers

### **Slide 18: Why the profound opposition to GM?**

There are many ideologies united in opposition to GM:

- Feminism (GM is a part of the technocratic system that oppresses women);
- Religious (GM is tampering with nature);
- Anti-globalization (GM is linked with technocracy and multinationals).

Evidence is probably largely irrelevant to those who are on an ideological mission. But I believe most members of the public do want evidence; especially as regards two compelling concerns about GM: its impact on the environment and health. And certainly these last two concerns are amenable to evidence

### **Slide 19: OK Monsanto have a bad reputation**

Multinationals have to be treated with caution – clearly their main agenda is profit. But as economist Jeffrey Sachs says in his book, “Common Wealth”, you should reward them when they do the right thing. Last month Monsanto vowed to double the yields of their commercial crops through GM and conventional breeding by 2030. And that they would do this while reducing by one third the amount of “key resources required” (presumably fertilizer and pesticides). They have also offered ten million dollar grants to outside researchers aiming to double the yields of wheat and rice – crops that Monsanto do not work on.

See <http://www.monsanto.com/responsibility/sustainable-ag/default.asp?WT.svl=2>

### **Slide 20: Environmental impact**

A GM crop is engineered to be a superior crop so naturally there are concerns that a superplant could cut loose and spread rampantly like “Triffids”— the imaginary plants dreamed up in John Wyndham’s novel.

The most likely way GM crops could have an adverse impact is if pollen from the GM crop spread to a wild relative of the crop. Not only would the wild relative be altered, which might be a problem if it’s an endangered species, but it could be transformed into a superweed. Other concerns are that the GM pollen would contaminate a neighboring commercial crop that the farmer is trying to keep GM-free, or the GM plant might have unexpected toxic effects on insects or other animals.

If you want an exhaustive doomsday list of all the things that might go wrong with a GM crop, there’s no better place to look than the risk assessments done by Australia’s Office of the Gene Technology Regulator. I suggest taking a look at the risk assessment and risk management plan for a banana genetically engineered to resist Panama disease and Yellow sigatoka by Professor James Dale’s team at Queensland University of Technology. Australia’s bananas are under threat by these diseases.

<http://www.ogtr.gov.au/internet/ogtr/publishing.nsf/Content/dir079-2007>

### **Slide 21: Real Concerns**

Scientists and regulators have been keeping their eyes peeled for the risks from GM crops.

GM Canola, for instance, is theoretically genetically close enough to wild radish (one of it’s most persistent weeds) to cross hybridize with it. But a study to look at this in 2001 found that even under the most conducive laboratory conditions the rate of cross pollination was four out of 100 million seeds. The bottom line is it’s a risk but seemingly a highly manageable one. See Rieger, M.A. et.al Theoretical Applied Genetics, 2001, vol 133, p.555

In Peru however the risk of GM potatoes mixing their genes with wild relatives was deemed too great. Regulators banned GM potatoes for this reason.

Pollen from GM canola can contaminate neighboring non GM canola. A study by Rick Roush and colleagues showed that pollen contamination within a 3 km radius amounted to about one in 10,000 plants. See Rieger, M.A. et al. “Pollen-Mediated Movement of Herbicide Resistance Between Commercial Canola Fields”, Science 296, 2386 (2002).

This level of contamination is way below the threshold of what the market requires to label canola as GM-free. For Australian canola grain, its 0.9%. See the Gus Nossal October 2007 review of the moratorium on Canola at :

<http://www.dpi.vic.gov.au/DPI/nrenfa.nsf/LinkView/5477226A88881F86CA2572E300074EEF89E6C67B468BD2A7CA256FB70001BAB8c>.

### **Slide 22: Percy Schmeiser –1000 acres of GM Canola, a case of contamination?**

Canadian Canola farmer Percy Schmeiser has been greatly celebrated as a case of a non GM farmer having his crop contaminated by a GM crop. Monsanto sued him after a test in 1998 showed that he was growing 1000 acres of GM Canola without having purchased the seed from the company. The company requires farmers to purchase GM Canola seed anew each

time. Planting “saved” seed (perhaps obtained from a GM farmer’s crop) is as illegal as pirating a videotape. Schmeiser claimed his crop had been contaminated by pollen blown in from neighboring fields and that he was simply re-using his own seed which had been accidentally fertilized by GM pollen. But 1000 acres of 95-98% GM canola simply can’t appear by *accident*. For one thing Schmeiser would have had to spray his field to “select” the herbicide tolerant individual plants. That’s certainly what the Canadian supreme court found in 2004. “The trial judge rejected the suggestion that it was the product of seed blown or inadvertently carried onto the appellant’s land”. See Melbourne University microbiologist David Tribe’s well referenced blog: <http://gmopundit.blogspot.com/2007/08/bbc-sucked-in-by-percy-schmeiser-flim.html>

### **Slide 23: Frankenfood**

The knee-jerk fear of GM is that the “natural” species barrier to gene trafficking is broken. In traditional breeding, genes can only travel between closely related species. In GM, you can put a flounder gene into a tomato. This taps into a primal fear—tamper with nature and you get something uncontrollable. But actually, the evidence shows that species barriers are breached in nature too. Viruses can shuttle genes from one animal species to another. And bacteria have quite an appetite for gobbling up and integrating foreign DNA as the following example shows.

### **Slide 24: Will antibiotic resistance properties be transferred to the micro-organisms in the human gut after the consumption of GM food?**

An experiment reported in 2004 by Trudy Netherwood and colleagues in the journal *Nature Biotechnology*, showed that bacteria in the human gut can take up transgenes present in food. The British researchers fed hamburgers containing GM soy to volunteers. The GM soy carried a transgene known as EPSPS; a bacterial gene that provides resistance to the herbicide glyphosate. When the researchers sampled the bacteria in the gut of these people, they found that a small percentage carried a fragment of the transgene. Surprisingly the transgene was detectable even before the people had eaten their GM burger. The authors suggest it reflected long-term exposure to the GM soy gene.

This unintended gene transfer from soy to human gut bacteria was somewhat alarming -- I certainly found it alarming. It means that the genes engineered into food could end up in the bacteria that share our intestine. What if some of these engineered genes changed the bacteria for the worse? What if an antibiotic resistance gene (which is often part of the transgene payload) got into these intestinal microbes and turned them into superbugs?

The answers to these hypothetical possibilities are two fold:

First the fact that the GM DNA occasionally gets into the rare intestinal bug, means that these bacteria must be imbibing DNA from our food all the time. That means that the transgene would be a drop in the ocean compared to the amount of DNA routinely imbibed by these cells. And though the potential exists for gut bacteria to imbibe a GM antibiotic resistance gene, these same genes are already present in many naturally occurring bacteria that enter the gut. David Tribe has a thorough discussion of this issue at: <http://gmopundit.blogspot.com/2006/04/gmos-and-movement-of-genes-between.html>

The author’s of the GM burger feeding study concluded that

*“it is highly unlikely that the gene transfer events seen in this study would alter gastrointestinal function or pose a risk to human health.... Nevertheless, the observed survival of transgenic DNA from a GM plant during passage through the small intestine should be considered in future safety assessments of GM foods.*

The bottom line is that this research shone the spotlight on a phenomenon that the research community hadn't widely appreciated: that genes do “naturally” move between species. It is now certainly something that genetic engineers and regulators have on their radar screens. See this excerpt below from a 2001 review. (procured from David Tribe's blog)

The results on the fate of food-ingested foreign DNA in the mammalian organism have been discussed among specialists concerned about food in general and about genetically modified organisms in the food chain in particular. Although it will be mandatory to consider this problem case by case, the food-consuming public can be reassured by the realization that all kinds of foreign genes in almost limitless combinations have been part of the food chain throughout the evolution of the species Homo sapiens and other species as well. For millennia, these genes and their breakdown products with high recombinatorial capacities have been constant partners in our gastrointestinal inner milieu and that of other species.

Doerfler W, Hohlweg U, Muller K, Remus R, Heller H, Hertz J. Foreign DNA integration--perturbations of the genome--oncogenesis. Ann N Y Acad Sci. 2001 Sep;945:276-88. Review

### **Slide 25: Greenpeace attacks the regulator FSANZ**

This was another story that initially caused me alarm. In March 2007, Greenpeace trumpeted the results of a Professor Seralini whose work was soon to be published in the Journal Archives of Contamination and Toxicology. The paper had reanalyzed studies performed by Monsanto on rats fed GM maize, or the unmodified maize variety strain. This GM maize variety goes by the name of MON863. Alarming, compared to rats fed the unmodified strain of corn, the rats fed MON863 showed changes to their blood cells and their organs were slightly altered. For instance their kidneys were smaller. Yet, as Greenpeace pointed out, Australia's and New Zealand's food regulatory authority (FSANZ) had passed the GM maize as safe. So had the food safety regulators of the US, Canada and Europe. Why would they do such a thing?

### **Slide 26, 27:**

The answer becomes obvious when you read the rest of the data Monsanto supplied to the regulators, but which Greenpeace ignored. It turns out the unusual rat symptoms weren't just seen with the MON 863 but also with six other varieties of GM corn that were not GM.

**Slide 28: Non GM corn shrinks kidneys**

This slide of Monsanto's data (obtained from the FSANZ website) shows how other varieties of corn also lead the rats to develop smaller kidneys. So the logical conclusion is that the regulators should either ban many varieties of conventionally -bred corn or accept that the response of rats fed GM corn falls within the natural variation.

**Slide 29: FSANZ, FDA, Canada, EFSA**

The Seralini paper has certainly alarmed the Austrian government which decided in August 2008 to ban MON 863.

But the decision of this government runs counter to the best advice of the European food safety regulator, EFSA. They took a look at the Seralini report and decided it "provided no evidence to indicate that MON 863 was associated with adverse effects in the 90-day rat study." See the excerpt below.

EFSA response now published as

Report of an expert panel on the reanalysis by Seralini et al. (2007) of a 90-day study conducted by Monsanto in support of the safety of a genetically modified corn variety (MON 863) FOOD AND CHEMICAL TOXICOLOGY, 45 (11): 2073-2085 NOV 2007  
Doull, J; Gaylor, D; Greim, H; Lovell, DP; Lynch, B; Munro, IC

Abstract:

MON 863, a genetically engineered corn variety that contains the gene for modified *Bacillus thuringiensis* Cry3Bb1 protein to protect against corn rootworm, was tested in a 90-day toxicity study as part of the process to gain regulatory approval. This study was reanalyzed by Seralini *et al.* who contended that the study showed possible hepatorenal effects of MON 863. An Expert Panel was convened to assess the original study results as analyzed by the Monsanto Company and the reanalysis conducted by Seralini *et al.* The Expert Panel concludes that the Seralini *et al.* reanalysis provided no evidence to indicate that MON 863 was associated with adverse effects in the 90-day rat study. In each case, statistical findings reported by both Monsanto and Seralini *et al.* were considered to be unrelated to treatment or of no biological or clinical importance because they failed to demonstrate a dose-response relationship, reproducibility over time, association with other relevant changes (e.g., histopathology), occurrence in both sexes, difference outside the normal range of variation, or biological plausibility with respect to cause-and-effect. The Seralini *et al.* reanalysis does not advance any new scientific data to indicate that MON 863 caused adverse effects in the 90-day rat study. (C) 2007 Elsevier Ltd. All rights reserved.

Sourced from <http://gmopundit.blogspot.com/2007/03/lies-damn-lies-and-statistics.html>

Also see: FSANZ

website:<http://www.foodstandards.gov.au/newsroom/factsheets/factsheets2007/updatefsanzreaffirms3622.cfm>

### **Slide 30: Why the distrust of regulators?**

European, US, Canadian, Australian and New Zealand food regulators all find MON863 to be as safe as the parent crop. (That also goes for all the GM crops on the market: soybeans, corn, canola, cotton.). These organizations represent the expertise of hundreds of toxicologists in five independent countries. Why then does Greenpeace reject the assessment of these experts in favour of one re-analysis of the same data by Seralini?

Seems to me there are three reasons:

1. The companies themselves produce much of the data, so it is seen as untrustworthy.
2. Regulators do not routinely require animal feeding studies
3. There is no mandatory labeling of GM food in the US and Canada (but there is in Europe, Australia and New Zealand) .

### **Slide 31: Untrustworthy data?**

Anti-GM campaigners distrust the findings of the regulators because much of the safety data are generated by the company wishing to market the product (eg Monsanto). It's claimed that these 'unpublished' data are *ipso facto* untrustworthy. An irony must be pointed out here. *Seralini was using Monsanto's own data to claim that MON 863 caused problems in rats.*

I would point to two things to contest the view that data produced by the companies are untrustworthy. First off, though it might seem compromising for a company to produce its own safety data, this is the standard way things are done in both food and drug safety evaluation. Companies either do the research in house or contract out the research to accredited laboratories. The data required to approve a drug or a new food is vast and extremely costly. Typically it takes a company a few hundred million dollars to put a new drug through all the safety trials. (For a GM crop, it takes about a hundred million). Few new drugs would come on the market if it were left to the public sector. By and large most drugs on the market have been proven safe – it's certainly in the company's interest for that to be the case. Occasionally there are failures like the Merck drug, Vioxx, which though a highly effective anti-arthritis drug caused heart attacks in some patients. Merck is paying for its error through lawsuits and a crashed stock value.

Second there are hundreds of *published* papers that attest to the safety of GM foods. David Tribe has assembled 202 of them. See <http://gmopundit.blogspot.com/2007/06/150-published-safety-assessments-on-gm.html>

### **Slide 32: Concern that animal feeding studies are NOT routinely required**

To get a GM food approved, food regulators in the US, Canada and here do not automatically require evidence from animal feeding studies. They base their safety evaluation on a knowledge of the composition of the transgene and a compositional analysis of the final food. In other words, they take a fine toothed comb through every known constituent of the food.

Follow this link to take a look at the summary of a GM corn evaluation by the FDA <http://www.cfsan.fda.gov/~rdb/bnfm107.html> and here to look at the entire list of completed

evaluations: <http://www.cfsan.fda.gov/~lrd/biocon.html> Basically they pore through the constituents of:

- minerals
- amino acids
- fatty acids
- anti-nutrients
- secondary metabolites
- vitamins

Primarily the regulators are looking for potential allergy inducing amino acids. There are data bases to crosscheck for the culprits. But tests will also be done to see whether amino acids in the GM protein have been modified in any way or are unusually stable to digestion –red flags for allergenicity. Professor T.J. Higgins at CSIRO was alerted to potential allergy problems in a GM pea variety he had developed based on this sort of test. (he told me this in a recent interview).

Personally I had a problem with the idea of “compositional analysis” being adequate to assess the safety of a GM product. It seems to me a little like saying you can analyze the contents of the universe, when we know that 90% is dark matter. I imagine there must be “dark matter” in food. So given you can’t be sure you can analyze everything that’s in food, it seems sensible to test GM foods in rat feeding studies.

Further reading showed me that the regulators are quite aware of this limitation. The reason they do not require routine animal feeding studies runs something like this: First, decades of food safety testing has alerted regulators to the major dangers of foods. Allergenic amino acids, toxins, and anti-nutrients (like phytins that block nutrient uptake) are all easily tested for.

Rat feeding studies on the other hand, turn out not to be that reliable. There have been cases where they fail to pick up an allergy problem in a GM product. (For instance rats failed to demonstrate the a Brazil nut protein transferred to soybean was allergenic Melo et.al 1994, Food Agric. Immunol. Vol 6, p.185) .

And they clearly throw up red herrings, as seen in the MON863 story. Variations occur from plant to plant and rat to rat. That evidently generates so much noise in the system that it’s hard to draw anything meaningful from looking at the size of rats’ organs after they’ve been fed different diets. It’s particularly noisy when the rats are unhealthy to begin with. Russian scientist Irina Ermakova became an overnight celebrity when she announced her “unpublished” rat studies showing that half her rat pups died after their mothers were fed GM soy. It’s a staggering result that has not been replicated by dozens of other researchers. One problem with Irmakova’s study is that her “control” rats were not in great shape either. 10% of them died at birth. This is a very high death rate. Experts say there was probably something very wrong with her rats to begin with. See “GM soybeans and health safety – a controversy re-examined”. Nature Biotechnology, Vol 25, 2007, p.981.

### **Slide 33: European Food safety review paper**

The European Food Safety Authority has just reviewed hundreds of papers and concluded that animal feeding studies have not added anything worthwhile to the compositional studies.

Nevertheless they still require these studies to be done in order to be able to tick that box in their assessment.

The US, Canada, Australia/ NZ regulators do not **automatically** require animal feeding studies.

### **Slide 34: Mandatory labeling**

I think the absence of mandatory GM food labeling in the US and Canada is another reason why regulators have curried mistrust. Certainly it makes it harder for studies to track GM food consumption in the population. That would be useful to prove or disprove claims about GM foods. For instance it is claimed that allergies have increased since the introduction of GM food to America. But allergies have also increased in Europe and Australia where rates of GM food consumption have been much lower. .

FSANZ, the food safety regulator for Australia and NZ *does* require mandatory labeling of GM food whether locally produced or imported. This does *not* apply to GM canola oil because there is no way to test for the presence of the GM product. The protein and DNA is refined out of the oil. If there is nothing to test for, FSANZ figures that mandatory labeling cannot be enforced or meaningful.

### **Slide 35: What are the costs of not adopting technology?**

We've always relied on technology to produce food. The Haber-Bosch invention in the early 1900s which made ammonia fertilizer through a chemical reaction solved the problem of the global manure shortage, and allowed the world to massively increase its food production. The green revolution of the 1960s produced new varieties of wheat and rice through intensive breeding, and Mexico, India and the Phillipines turned around their famines to become exporters of grain.

But the race to stay ahead of pests while feeding a growing population never ends. Now farmers also have to cope with drought, floods (due to climate change), salinity and generally they have to do this using the same amount of land or start using much less productive lands.

GM crops have already delivered. Farmers have gotten new tools to keep them ahead of weeds and pest while using more benign methods of pest control than they did before.

GM papaya has saved the Hawaiian papaya industry against papaya ringspot virus. GM bananas might protect Australia's crop from Panama disease. New varieties of crops are waiting in the wings that are nitrogen efficient, drought and salt and pest resistant.

Some are being developed by big companies. Others are being developed by public agencies. Like pest-resistant cowpeas being developed by T.J. Higgins at CSIRO that could boost yields many fold for poor African farmers too poor to afford pesticides. See [www.pi.csiro.au/enewsletter/PDF/PI\\_info\\_Cowpeas.pdf](http://www.pi.csiro.au/enewsletter/PDF/PI_info_Cowpeas.pdf) -

### **Slide 36: Golden rice – have the anti-GM activists stymied public good?**

Golden rice was developed by Ingo Potrykis, a Swiss scientist at a public institute for plant sciences. He developed it to address the vitamin A deficiency of children in the developing world which causes 500,000 each year to go blind. Ten years after his invention, he feels that regulation has stymied him. He feels that only the big companies will be able to afford the 100 million dollars it takes to get a product through the regulatory hoops. Greenpeace

have been his staunch enemy. They have attacked his work on any level they can. For instance, they claimed that his first breeds produced too little vitamin A to make a difference. But that was a prototype. Should the Wright brothers have given up on aircraft design because their first craft couldn't get across the Pacific? The latest breeds of vitamin A rice produce enough vitamin A to make a difference. See "Tough Lessons From Golden Rice", Martin Enserink, *Science* 2008:, Vol. 320., pp. 468 – 471

**Slide 37: Safety of golden rice compared to traditionally bred**

These slides from Ingo Potrykis's web page show how dramatically modified both GM rice and conventionally bred rice are compared to the "natural ancestor".

**Slide 38: Summary**

Weighing the evidence for and against GM food is a tough job. Many of the arguments require you to wade right into the science and arbitrate between opposing scientists. Some of the evidence from Greenpeace is very misleading because it leaves out key parts of the picture.

My reading of the case is that GM technology is a powerful tool that we cannot afford to throw away.

There are risks. Twelve years of growing GM crops in Canada and America has shown which ones are significant and which ones aren't; and how to deal with them.

The regulators take a fine tooth combed to safety assessment—it takes them about a year to process the data. Each case is different.