Genetic Engineering FAQs

Frequently Asked Questions

Physicians and Scientists for Global Responsibility
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committed citizens can change the world.
Indeed, it is the only thing that ever has."

Margaret Mead.

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What is genetic engineering?

Genetic engineering (GE) is the artificial, direct alteration of an organism's DNA and usually involves genes being taken from a natural host and inserted into a new host. For example:

- New Zealand researchers have engineered genes from a toad and inserted them into the chromosomes of a potato; they have also inserted human genes into the DNA of cows;
- US researchers have extracted rat genes and inserted them into lettuce, corn/maize and rice to produce rat proteins in those plants; they have genetically engineered plants to make their seed completely infertile, or in need of an application of a proprietary chemical in order to germinate.

The word modification is commonly used in place of engineering to refer to procedures that change the DNA of an organism, and biotechnology has often been used interchangeably with genetic engineering. In fact, GE technology is only a part of biotechnology.

Biotechnology has recently added much of value to our agricultural and scientific heritage. However, the trial and error approach to evaluating the effects of genetic engineering is inappropriate and dangerous when novel organisms are released into the environment.

The complex inter-relationships between organisms are genetically determined in ways about which we have little knowledge.

Is GE safe?

Proponents of GE have claimed that the result of transferring a gene from one organism to another is specific, precise and predictable, and therefore safe. They also claim that it will have only observable or predictable impacts on an organism’s genetics and ecology. In fact, scientists have yet to perfect the technology needed for the insertion of a single DNA sequence accurately into a specific location within a chosen organism’s genome.

Many benefits have come from our increasing knowledge of DNA, genes and genomes. For example:

- Forensic DNA testing and identification;
- Diagnosis of genetic disorders;
- Micro-array technology for direct observation of gene activity;
- DNA markers assisting genetic selection for crop development.

However, many aspects of genetic engineering technology raise ethical issues needing evaluation and legislation. Here are some examples.

- Patenting living organisms inhibits some worthwhile medical research.
- Identifying genetic features associated with clinical disorders often poses a difficult dilemma for the patient.
- Antibiotic resistant marker genes in GE food crops may contribute to some antibiotics becoming ineffective.
- Proteins produced by using GE technology and administered to patients as medicines can be identified as foreign bodies by the immune system leading to adverse reactions, even death.
- The use of seed sterilization technologies to maintain control of biological resources denies farmers their traditional right to save seed. This disrupts wise farming practice and makes farmers vulnerable to the fortunes of multi-national companies.

No long-term, independent safety tests have been carried out on the effects of daily ingestion of a variety of GE foods. A study on human volunteers proved transgenic DNA crossed to gut bacteria after just one meal containing transgenic soy.

Our knowledge of DNA and its functions is still primitive. Research should continue under the strict control of laboratory confinement.

Is GE the same as selective breeding?

No. Selective breeding involves crossing closely related varieties or species whose genes are mostly similar in structure and function.

Horticulturalists can cross two varieties of rose to create a new variety, a horse can cross with an ass, but scientists cannot naturally cross a rat with a lettuce, or a toad with a potato, or a fish with a strawberry.
Conventional breeding techniques and hybridisation are very different technologies from genetic engineering.

How is genetic engineering done?

- A section of DNA whose genetic function is associated with some characteristic of an organism is first isolated. Some functional sequences of DNA can be identified quite precisely.
- The isolated genetic information is then inserted into the genome of a new host. This requires the construction of a vector that can invade the genome of the new host and insert the foreign DNA sequences into it.
- Most commonly, the inserted DNA sequence is made up of a transgene (the chosen genetic information), a marker gene (usually conferring antibiotic resistance) and a promotor sequence that encourages expression of the new gene(s) in the target cells.
- When the foreign transgene is expressed in the target cells, a novel protein is commonly produced as a result. The incorporation of the vector cargo into the target genome is still a hit and miss process.

Genes operate in highly complex, barely understood relationships. A change at any point in the DNA of the new host can affect the function of genes throughout the genome in unpredictable ways.

Large-scale agricultural applications of GE biotechnology have thoughtlessly imposed massive impacts on our food supply that have not been adequately investigated. Claims of safety are based on questionable assumptions that do not hold up to rigorous, independent scientific review.

How is the function of genes affected in unpredictable ways?

Insertion of novel DNA into a genome may:

- Disrupt vital genes; this effect cannot be overcome with certainty in the hit-and-miss process of DNA insertion;
- Cause the production of allergens and proteins that were never present previously in the human diet;
- Cause toxic chemicals to be produced;
- Interfere with the function of chemical signalling processes;
- Inhibit or make unstable the function of other genes in the host;
- 'Silence' genes so that they do not function.

Should we be concerned about GE crops?

There are grounds for serious concern about GE crops, especially the diversion of global agricultural resources into this new mode of production.

The Royal Societies in the UK and Canada, the French Food Safety Authority, and many eminent scientists and medical professionals worldwide have urged caution. These are some of the concerns.

- Antibiotic-resistant marker genes are commonly incorporated into GE variant organisms. Further proliferation of these genes may enhance antibiotic resistance of microbes harmful to humankind and animals.
- The vectors used to engineer new genes into cells often have features that can facilitate further horizontal gene transfer. Retention of such features by the inserted genetic sequence can confer instability, raising the probability of subsequent horizontal gene transfer into non-target species.
- Corn/maize engineered with genes from the Bt bacterium (Bacillus thuringiensis) produce a Bt insecticide in every cell of the plant. The epidemiological effects of large-scale ingestion of such toxins have not been studied.
- Engineered genes do not remain contained in their target organisms. They have crossed between corn/maize varieties, between canola varieties, and between transgenic crops and wild relatives.

- Introduced genes may sometimes be transferred to other species in a process called horizontal gene transfer.

What is horizontal gene transfer (HGT)?

We know that genes move freely between varieties that interbreed. More rarely, genes move from one species to another, usually between closely related species. These relatively rare events occur more often in the microbial world than elsewhere. The process is known as HGT or horizontal gene transfer, and occasionally referred to as lateral gene transfer.

Horizontal gene transfer between species from different kingdoms, like animals, plants and microbes, is extremely rare in nature, even on an evolutionary timescale. However, scientists at the University of Rochester discovered a copy of the entire genome of a bacterial parasite residing inside the genome of its host species. This suggests that horizontal gene transfer may occur more frequently between bacteria and multi-cellular organisms than was previously believed. The parasite had implanted itself inside the cells of 70 percent of the world's invertebrates, co-evolving with them. The scientists concluded that the parasite, Wolbachia, might be the most prolific parasite in the world. It invades a species and eventually makes its way into the host's eggs or sperm. This ensures passage to the next generation of its host, and any genetic exchanges between it and the host also are much more likely to be passed on.[1]

Earlier, a Wolbachia gene was discovered in a beetle by the Fukatsu team at the University of Tokyo, Japan, and a scientist at the J. Craig Venter Institute found evidence that some Wolbachia genes seemed to be fused to the genes of the fruit fly, Drosophila ananassae, as if they were part of the same genome[2].

Genetic engineering has now become the main cause of HGT in the biosphere. Novel genes introduced into one host using genetic engineering technology may be more prone to further transfer because of the way they have been inserted.

Findings regarding HGT include:

- GE glyphosate-resistance has been found in weeds; reported at an International Weeds Conference, organized by the British Crop Protection Council.
- Genetic and chemical tests have confirmed that stray canola plants in Canada were resistant to three agrochemicals, Roundup, Liberty and Pursuit.
- When a weed crossbreeds with a farm-cultivated relative and acquires new genetic traits – including engineered genes that make it hardier – the hybrid weed can pass the traits on to future generations. The result may be very hardy, hard-to-kill weeds.

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[1] Science, 30 August 2007.

[2] See www.sciencedaily.com/releases/2007/08/070830150118.htm

- Gene flow from herbicide-resistant canola crops to nearby non-GE crops has been observed. Transgenic canola pollen travels hundreds of metres, making it impossible to separate GE crops effectively from conventional or organic crops.
- Native corn/maize land races in Mexico have been contaminated with DNA from GE variants. Government scientists have confirmed this.
- Transgenic DNA in GE soy has been found to survive passage through the small bowel and be taken up by human gut bacteria.
- A promoter derived from GE plants has been found in a conventional canola variety.
- Conventional potatoes have been found contaminated with DNA from GE potatoes planted up to 1100 metres away.

Genetically engineered traits and seed may be transported by any of the following means:

- By horizontal gene transfer (HGT);
- Through stock into manure; on farm vehicles or human footwear;
- By being blown off trucks transporting seed; co-mingled with conventional seed in handling, transport or storage; in food and stock feed processing;
- By rain- and floodwater; and as wind-borne pollen.

Two studies commissioned by the UK Soil Association found none of the crops considered had pollen that could be completely contained. In particular, corn/maize presented a medium to high-level risk for cross-pollination with other corn/maize crops as the pollen could spread on the airflow (Tauber).

A study of rain in Northwest India led the researchers to conclude that long distance dispersal could allow pollen grains to travel 600 km (Sing et all, 1993).

A frontal storm can quickly lift air masses skywards several kilometres (Emberlin et al) carrying pollen grains with the airflow (Faegri & Iverson 1989). Once in the upper atmosphere, pollen can travel for hundreds of kilometres at a range of 25-50 metres per second, before being deposited or captured by rain droplets (Mandrioli et al 1984). Pollen grains can also be re-suspended from surfaces and re-deposited at other locations. [3]

Monsanto and Scotts of Marysville, Ohio, developed a Roundup-resistant strain of creeping bentgrass for golf courses, and Scotts plan to engineer other lawn grasses. A study undertaken at an EPA research centre in Corvallis, Oregon, found that genes from transgenic grass could spread much further than previously thought. Creeping bentgrass has very light seeds that disperse readily in the wind, has very light pollen, and can also cross-pollinate with at least 12 other grass species. The EPA scientists found that the GE bentgrass pollinated test plants of the same species as far as they measured, about 21 kilometres downwind from the

[3] Erdtman; Faegri and Iverson 1989.See also Emberlin, Adams-Groom and Tidmarsh, 'A Report on the Dispersal of Maize Pollen,' January 1999; Treu and Emberlin, 'Pollen dispersal in the crops Maize [Zea mays], Oil seed rape [Brassica napus ssp olerifera], Potatoes [Solanum tuberosum], Sugar beet [Beta vulgaris ssp vulgaris] and Wheat [Triticum aestivum], January 2000.

test farm. Nearly 15 kilometres away, wild grass of a different species was pollinated with the bentgrass transgene.[4]

What traits do GE plants have?

The traits genetically engineered into transgenic plants fall into six broad categories. Some plants are engineered with more than one trait, which is called ‘gene stacking.’

Insect resistance, using genes from Bt (Bacillus thuringiensis - a soil bacterium):

- Corn, cotton, potato, tomato

Herbicide resistance (the largest percentage resistant to glyphosate and glufosinate):

- Corn, soybeans, cotton, canola, sugar beets, rice, flax, tobacco.
  N.B. Herbicide-resistant and Bt crops dominate the transgenic seed market.

Virus resistance:

- Squash/zucchini, papaya, potato, plant viruses
- Delayed fruit ripening, using a soil bacterium or a virus:
- Tomato
- Altered oil content, using bay or soybeans:
- Canola, soybeans
- Pollen control, using a soil bacterium:
- Corn, chicory (radicchio)

Many modifications, created in laboratories, and some even approved for experimental field trials, never reach the consumer. For example:

- Tomatoes with fish antifreeze genes inserted were unsuccessful. Transgenic tomatoes that were marketed were said to taste “metallic” and have tough skins
- Soybeans with Brazil nut allergens were never marketed. An allergy to Brazil nuts is not uncommon
- Potatoes with snowdrop toxins were never marketed
- Rice that produces extra vitamin A has not yet been submitted for regulatory approval; studies show that it compares poorly in comparison with eating a handful of “green” vegetables
- ‘Terminator’ seeds that are sterile are not yet commercialised. These plants would not produce viable seed. May also be referred to as Trait-specific Genetic Use Restriction Technology or GURT. ‘Traitor’ or ‘T-gut’ technology requires a chemical application as a catalyst to reactivate engineered traits. Currently, Traitor technology is reported to be under development by the biotechnology companies, Monsanto and AstraZeneca.

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[4] Watrud, L S, et al, J. Proceedings of the National Academy of Sciences, September 2004.

- Transgenic wheat. The introduction has prevented via pressure from growers and consumers.

Proposed developments include increasing or adding nutrients: e.g. the development of rice to provide Vitamin A; a rat gene inserted into lettuce to produce more Vitamin C.[5]

Crops are being grown to produce pharmaceuticals, vaccines and industrial chemicals. Animals are being engineered to produce nutrients in their milk. Trees are engineered to increase growth rate, cellulose content and other traits. Fish have been genetically engineered to make them grow faster and larger, and to make them glow in the dark.

How will GE affect consumers?

Genetic engineering experiments are taking place:

- With commercial crops such as wheat, rice, grass, trees grown for fruit, timber and paper; with insect pests, fish, poultry and animals;
- With foods, food additives and enzymes, often to improve shelf-life;
- In the production of dietary supplements;
- In medicine, such as in the production of pharmaceuticals; and in medical therapies;
- With plants to produce drugs and vaccines;
- With crops to produce chemical compounds used in the laboratory;
- In science, with analytical applications.

The vast majority of transgenic crops are engineered to make them resistant to herbicides like glyphosate (RoundupReady) or glufosinate, or to contain an insecticide derived from the soil bacterium, Bacillus thuringiensis (Bt).

The transgenic effects are usually manifested in all parts of the plant. Before food derived from RoundupReady crops was approved for sale in New Zealand, regulatory authorities increased the amount of residual glyphosate allowed in food 200-fold.

A gene transferred from rapeseed (canola/oilseed rape) that had been engineered to resist the herbicide glufosinate has been found in bacteria and fungi residing in the gut of honeybees.

There are no definitive studies on how Bt affects human consumers. In fact, no one knows how ingesting GE food on a daily basis will affect human health in the long term. GE foods have been introduced into the food chain without adequate testing and there have been no proper epidemiological studies to investigate their consequent effects.

Are GE foods labelled?

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[5] See http://www.eurekalert.org/pub_releases/2001-07/vt-rgi072701.php.

Some countries have introduced labelling laws for GE foods; most are not extensive enough. New Zealand has labelling regulations, which many feel are inadequate. Some foods are exempt.

Mandatory 'Country of Origin' labelling would help consumers to choose GE free products by avoiding those from countries known to grow GE crops commercially.

Can you insure against damage from transgenes?

Insurance companies have said they will not insure against the effects of GE crops and governments are reluctant to legislate, claiming that liability for any damage is 'socialized'.

New Zealand's Minister for the Environment, David Benson-Pope, has confirmed that if transgenic contamination occurs it will be the person or persons affected by the pollution who will pay, i.e., local councils and growers, not the polluter.

An increasing number of New Zealand Councils are looking at the issue of how to handle genetically engineered organisms in their region. Concerns cover contamination, and the impact on local industry, agriculture, health and tourism.

Interested parties can make application to New Zealand's Environmental Risk Management Authority (ERMA) for approval to trial or grow transgenic crops commercially. Currently, no transgenic crops are grown commercially in New Zealand, but approval has been given for a variety of experimental crops: onions and other Alliums, brassicas and trees.

Food Standards Australia New Zealand handles applications to use foods and additives produced using genetic engineering technology.

On what basis are novel DNA creations patented?

For patenting purposes, the US Patent and Trademark Office defines a gene as an ordered sequence of DNA "that encodes a specific functional product." This is not far removed from the definition used by scientists who invented recombinant DNA in 1973. They worked on the one gene, one protein principle and, even today, some proponents of genetic engineering technology continue to maintain that a gene from any organism could fit neatly and predictably into a new host.

Dr Jack Heinemann, professor of molecular biology in the School of Biological Sciences at the University of Canterbury and director of its Centre for Integrated Research in Biosafety in New Zealand, has labelled this "the industrial gene" and says that it "is one that can be defined, owned, tracked, proven acceptably safe, proven to have uniform effect, sold and recalled."

In 2007, ENCODE (Encyclopaedia of DNA Elements), an international consortium organised by the US National Human Genome Research Institute, published the results of its study to build a "parts list" of all biologically functional elements in one percent of the human genome. It found that the human genome might not be a "tidy collection of independent genes" with each sequence of DNA linked to a single function, such as a predisposition to diabetes or heart disease. Instead, genes appear to operate in a complex network, and interact and overlap with one another and with other components in ways not yet fully understood. It also found that genes make up only a tiny fraction of the role played by the three billion letters that constitute the human genome. DNA, routinely labelled "junk" because it is thought to serve no practical purpose, has been found to be highly active inside the body's cells.

Manolis Dermitzakis of ENCODE said: "If you think of the letters that make up the human genome as the alphabet, then you can think of genes as the verbs. We're identifying all of the other grammatical elements and the syntax of the language we need to read the genetic code completely." This underlines the importance of individual genes. (See Nature, Science and New Scientist 14 June 2007.)

One study found over 4000 human genes had been patented in the US alone by 2005, a fraction of the total number of patented plant, animal, and microbial genes worldwide. ENCODE's findings now raise fundamental questions about the defensibility of those patents; e.g. if genes are only one component in how a genome functions, will infringement claims be subject to dispute when another crucial component of the network is claimed by someone else and might owners of gene patents find themselves liable for unintended collateral damage caused by the network effects of the genes they own?

ENCODE's findings also raise safety issues. Evidence of a networked genome undermines the scientific basis for virtually every official risk assessment of genetically engineered products, from crops to pharmaceuticals.

Professor Heinemann has noted:

> "The real worry for us has always been that the commercial agenda for biotech may be premature, based on what we have long known was an incomplete understanding of genetics. Because gene patents and the genetic engineering process itself are both defined in terms of genes acting independently, regulators may be unaware of the potential impacts arising from these network effects."[6]

Genetic engineering and agriculture

How does genetic engineering fit in with agriculture and exports? Is it the answer for the future of agriculture? In 1999, the US, Canada and Argentina grew 99 percent of all GE crops planted. In 2007, over 70 percent of commercial plantings, of the more than 114 million hectares worldwide, were still confined to the US and Argentina.

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[6] www.nytimes.com/2007/07/01/.

A report in Science Magazine[7] outlined that just eight countries grow over 99% of the world's transgenic crops; the main ones being soy, maize, cotton and canola/rapeseed.

- Of the almost 58 million hectares in transgenic crops in the US, soy and corn/maize cover the largest acreages. Widespread use of herbicide-resistant crops has led to glyphosate-resistant weeds in 19 states, which has increased herbicide applications overall. Glyphosate usage on GE soy plantings has more than doubled since 1996. (Glyphosate is the active ingredient in the herbicide Roundup.)
- Since transgenic crops were first commercialised in 1996, Argentina has virtually stopped growing conventional soy and now has just over 19 million hectares in GE soybeans. It will not recognize Monsanto's patent on RoundupReady soy, and the company claims that 30% of Argentina's production uses black market-purchased RoundupReady seed. It has petitioned to change the royalty collection system so that royalties are collected at harvest rather than upon purchase of the seed.
- Brazil, the third largest exporter of corn/maize, has 15 million hectares in GE crops. In February 2008, it approved two further varieties for planting, despite its health ministry not yet declaring them safe to eat.
- Canada is the world's top exporter of canola/rapeseed and grows seven million hectares of GE crops. Its transgenic canola/rapeseed acreage grew by 15% in 2006–2007 and GE varieties form almost 90% of its canola/rapeseed production. A growing quantity of the yields is going to the new bio-diesel industry.
- India has 6.2 million hectares in transgenic crops and grows more GE cotton than any other country. To date, it has not commercialised or imported any GE food crops. The first exception may be insect-resistant Bt Brinjal (eggplant/aubergine) currently undergoing field trials.
- China has an ambitious research programme and has almost four million hectares in transgenic crops. Its transgenic cotton competes profitably with varieties developed privately. Reports say that field trials are being carried out on at least a dozen GE food crops.
- Paraguay did not allow GE soy planting until 2004 and now has almost three million hectares growing, 94% being herbicide resistant.
- South Africa is the only country on the African Continent to approve the commercial release of transgenic crops and now grows almost two million hectares. In March 2008, it was criticised when shipments of seed corn/maize to Kenya were contaminated by transgenes.

'Who Benefits from GM crops? An analysis of the global performance of genetically modified (GM) crops 1996-2006' is the 2008 report from Friends of the Earth (FoE) International.[8] It claims that transgenic crops have failed to address the main challenges

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[7] (27 April 2008) Science Magazine (www.sciencemag.org) lists its sources as the Centre for Food Safety, USDA, ISAAA, agbios.com, www.gmo-free-europe.org and the Austrian Embassy.

[8] N.B. The FoE report coincides with the release of the annual 'Global Status of Commercialised Biotech' report of the industry-sponsored International Service for the Acquisition of Agri-biotech Applications (ISAAA), which promotes transgenic crops as a key solution to hunger and poverty. (Full report on www.foei.org.)

facing farmers in most countries and says that the 'second generation' of transgenic crops with attractive 'traits' promised by the industry has failed to appear.

Nnimmo Bassey of Friends of the Earth Africa, Nigeria, has stated:

> "No GM crop on the market today offers benefits to the consumer in terms of quality or price, and these crops have done nothing to alleviate hunger or poverty in Africa or elsewhere."

Are there benefits to farmers growing GE crops?

US farmers who bought into GE technology were promised higher yields and reduced pesticide use, and therefore bigger profits. What they found was that the primary beneficiaries of GE herbicide-resistant soybean and Bt corn/maize are the companies that supply the seed and the chemicals.

Farmers growing GE crops:

- Pay biotech developers a technology fee when they purchase and plant GE seed;
- Agree not to save seed for the next season's planting; and
- Agree to allow crops to be inspected.

What are the costs to farmers?

As of writing, Monsanto reportedly has a department of around 75 employees and sets aside an annual budget of US$10 million for the sole purpose of investigating and prosecuting farmers for infringement of its patents.

Since the mid-1990s, Monsanto has sued around 150 (mainly) US farmers for patent infringement in connection with its transgenic seed and the company says it follows up on approximately 500 cases of suspected infringement each year. Many cases are settled out of court.

The most common claim made by the company is violation of a technology agreement that prohibits farmers from saving seed from one season's crop to plant the next year.

An early case, in 1998, came about because Monsanto's patented seeds infected and pollinated farmland owned by Canadian farmer, Percy Schmeiser.[9] The cross-pollination destroyed seed developed by Schmeiser during his forty years of farming. Monsanto claimed Schmeiser, then seventy years old, had stolen their patented seeds. The Monsanto Canada Inc. v. Schmeiser case went to the Supreme Court. In March of 2001, Supreme Court Judge, W Andrew MacKay, ruled that Schmeiser had violated Monsanto's genetically engineered

[9] (www.percyschmeiser.com).

patent. The court rejected Monsanto's claim for damages and did not impose punitive damages on Schmeiser.

In 2005, more transgenic canola emerged on Schmeiser's land and he was ordered to remove it. This he did by picking out the GE canola himself and he sent Monsanto a bill for $660. In March 2008, Monsanto Canada agreed to meet this clean-up cost. A significant part of the deal reached in the small claims court hearing is that there is no gag order on Schmeiser and that Monsanto may be sued again if further contamination occurs.

One farmer received an eight-month prison sentence, in addition to having to pay damages, when a Monsanto case turned into a criminal prosecution.

Seed cleaner, Mo Parr, at 74-years-old, was hired by farmers to separate debris from seed to be replanted. Monsanto sued him, claiming he was "aiding and abetting" farmers violate their patent. The company subpoenaed Parr's bank records without his knowledge and located his customers. Monsanto won the case.

Settlements are often high. For example, in Monsanto Co. et al v. Thomason et al, the defendants had to pay US$447,797.05 to Monsanto and $222,748.00 to Delta Pine in damages, settle US$279,741.00 in attorney fees to Monsanto, $57,469.13 in costs and advanced expenses, and $75,545.83 for testing fields, as well as additional attorney fees to Delta Pine to the tune of $82,281.75, and $5,801.00 in costs and advanced expenses.[10]

The lengths which Monsanto will take in court to protect its products was further illustrated when, in 2003, it sued the Oakhurst Dairy, Maine, because it advertised its milk products as not coming from cows treated with Monsanto's recombinant bovine growth hormone (rBGH or rBST, marketed as Prosilac).

In 1997, Fox News reportedly bowed to pressure from Monsanto to suppress an investigative report on the health risks associated with Prosilac - a synthetic drug used to increase milk production in cows. It is banned in most first-world countries, with the exception of the US, where it can be found in much of the milk supply. Fox pressured its reporters, Steve Wilson and Jane Akre, to alter their report, despite evidence that Monsanto had lied about the risks of contaminated milk and infected cattle. The reporters refused to comply and were fired. Wilson and Akre then sued Fox News, claiming they could not be fired for refusing to do something that they believed to be illegal. The 2000 finding in a Florida court in favour of the reporters was overturned in 2003 by an appeals court on a technicality in the interpretation of the statute under which the original case had been filed.[11]

Could any of this happen to farmers in New Zealand?

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[10] See also www.nelsonfarm.net. www.cbsnews.com/stories/2008/04/26; http://en.wikipedia.org/wiki/Monsanto.

[11] Note: The reporters' struggle with Fox News is ongoing. The findings in their original report were never directly challenged, and the story can be seen in the feature length documentary film 'The Corporation.'

Yes, potentially it could, if New Zealand approved commercial plantings of transgenic crops.

Farmers cannot insure against contamination. Worldwide, insurance companies have stated they will not carry insurance against damage or contamination from GE crops.

On 26 July 2007, New Zealand's Northern Advocate reported that in response to a request from Northland's councils, Environment Minister, David Benson-Pope, confirmed in writing that local growers and local bodies will be liable for any clean up necessary after contamination from transgenic field trials or crops. For any transgenic contamination, it will be the person or persons affected by the pollution that will pay, not the polluter.

Why are farmers are turning their backs on GE crops?

Here are some of the reasons:

- At the time of the introduction of commercial GE crop production in the mid 1990s, US corn/maize exports to Europe were 2.8 million tonnes (1995-96). The World Commodity Analysis Corporation and the US Department of Agriculture found this figure dropped to 2300 tonnes in 2000-01. Canola/rapeseed exports from Canada to Europe dropped in a similar way. Export customers did not want GE crops or crops contaminated by GE seed. By 2008, sales of corn/maize had been boosted by the use of grain crops to produce biofuels. Even so, the Economic Research Service, which is part of the US Department of Agriculture, says corn/maize exports are expected to decline 8 percent in 2007/08 and fall again in 2008/09 (www.ers.usda.gov).
- As CEO of the American Corn Growers Association (ACGA), Gary Goldberg said it was a case of "if we knew then what we know now" farmers in the US would not have been convinced that genetically engineered crops were viable improvements on conventional crops. Farming land has become contaminated with transgenic pollution that "we cannot control or remove from our environment." He adds that, "Conventional farms are being contaminated, and we have no choice of GE or non-GE crops." He also says that none of the promises made by GE promoters have come true and that US farmers "are losing export markets."
- In a survey, the ACGA asked its members if - based on their experiences as growers of transgenic crops - they would in the future plant more or fewer acres of genetically engineered corn/maize. Farmers across many states were questioned. State by state, 65 to 100 percent said they would grow fewer acres of transgenic corn/maize.
- Rigorous comparative studies of crops have shown that yields of transgenic crops are generally lower than their non-GE counterparts. In 2002, an extensive analysis of the economic performance of transgenic crops in the US by its Department of Agriculture concluded that it was difficult to explain the rapid adoption of GE crops when farm financial impacts appeared to be mixed or even negative. Their 2006 report concluded that, driven by farmers' expectations of higher yields, savings in management time, and lower pesticide costs, the adoption of corn/maize, soybean, and cotton GE varieties has increased rapidly. However, despite any benefits, environmental and consumer concerns may have limited acceptance of GE crops,

particularly in Europe. Independent reports have consistently contradicted reports from government agencies and industry.

- Bill Christison, President of the US National Farming Family Coalition, said contamination during processing could not be prevented, and that it would be virtually impossible for genetically engineered, conventional and/or organic crops to co-exist without transgene contamination occurring. Commenting on the promoters' promises that farmers would use fewer chemicals and would produce a greater yield, he said, "None of this is true."
- •In 2000, Tasmania acknowledged that transgenic canola/rapeseed volunteer plants had been found flowering at 11 locations following a Commonwealth audit of trial sites used by the biotechnology companies, Aventis and Monsanto. Subsequently, it has been claimed that these volunteers and re-growths were not adequately followed up. Authorities failed to reveal the locations of the trials sites. The Tasmanian Government imposed a moratorium, later extended to 2008.[12]

NZ is relatively untouched by GE crop contamination. Should New Zealand ignore the experiences of farmers overseas or risk what may be an irreversible and damaging form of production?

New Zealand's economy relies on our image as a clean, green, natural tourist destination and producer of food, and other export products. It is vital to the future of this country to make this image a reality by protecting the environment and our reputation.

New Zealand has no commercial GE crops and remains comparatively untouched by transgenic contamination. Our major producers avoid GE because people buying New Zealand products locally and overseas want GE-free produce. This is part of the global macro-trend in the demand for food which is natural, authentic, ethically produced, of low-chemical residue and organic.

Based on the experiences of farmers overseas, GE contamination would be against New Zealand's interest. As well as problems with GE crops - reduced yields, increased chemical absorption and the development of resistant pests - contamination would damage our export image and market position.

The largely grass-fed dairy herd in New Zealand is scrapie-free and has no recorded BSE. The dairy industry would be devastated by the outbreak of a serious disease, like Foot and Mouth, or by a GE bio-security scare linked to animal products.

[12]www.genet-info.org; www.excite.com.au; www.health.gov.au; www.themercury.news.com.au.

Whilst some contained ethical uses of gene science are already common in New Zealand, GE commercial release presents a threat to the economy and remains widely opposed by a majority of New Zealanders.[13]

A 2008 report revealed that the New Zealand Government has instigated only 20 of 49 recommendations, and only one of the "watershed" recommendations, made by the Royal Commission on Genetic Modification (RCGM) in 2001. The Commission's recommendations were designed to protect the New Zealand environment, its economy and its people. The 2008 report was produced by the research organisation, Sustainable Future (SF), a think-tank specialising in sustainability issues affecting the country. SF says the government has failed to build all the strategic "watershed" recommendations and the framework to protect co-existence between GE and non-GE producers in New Zealand.

The New Zealand government has also failed to deliver on the 2005 co-operation agreement it made with the country's Green Party. It would not agree to the Green Party's preference for no release into the environment or onto farms of living GE organisms. However, the post-election agreement includes the words, "to increase the certainty around the ability of non-GM (genetically modified) producers to maintain GM free production and be able to identify their product as such to meet market access requirements."

The basis of the RCGM Report was "preserving opportunities." Eight of the 49 recommendations were designed to ensure that any release of GE organisms did not contaminate the products of other growers, including beekeepers.

NZ government agencies are currently perceived to be supporting larger and more risky field trials: e.g. the 2008 application to the Environmental Resource Management Authority (ERMA) by the Institute for Crop & Food Research for a trial that would allow plants to flower and seed, and which risks contaminating the country's safe and GE-free food supply brands.

What is at stake is New Zealand's market access to food that can be guaranteed GE free, as is preferred by its export customers in Europe, Japan and other overseas markets.[14]

How is bio-security affected by transgenes?

- Proteins of transgenic origin found in Canadian honey exported to the European Union (EU) resulted in a drop in honey exports to Europe by 55%.[15]

[13] See the Sustainability Council independent survey; the BERL [Business and Economic Research Ltd] Report on www.treasury.govt.nz/gmeconomic, www.mfe.govt.nz or www.beehive.govt.nz. See also The Biotechnology Taskforce report, 'Growing the Biotechnology Sector in NZ - A Framework for Action'.
[14] 'Report exposes Government inaction over GE,' 16 April 2008, Scoop - Independent News.

[15] Smyth et al., 2002

- In 1998, StarLink GE corn was approved by the US Environmental Protection Agency for industrial uses and as animal feed, but not for use in human food products. In 2000, traces of its transgene, Cry9C, were found in tacos, leading to the recall of over 300 products sold in the US and the cancellation of its registration that October. The USDA found the transgene in nearly ten percent of tests taken after November 2000. In 2008, an EPA White Paper reported that, in the testing period from October 2005 to September 2006, 0.1% of all grain sampled tested positive for Cry9C. The StarLink transgene has persisted and has been detected in corn/maize in Canada, Bolivia, Egypt, Japan, Nicaragua, and South Korea.[16]
- There have been nearly 1000 transgenic contamination incidents in the decade to 2007 according to a Greenpeace report. Of the 15 transgenic contamination incidents reported worldwide in 2006, nine involved food, four seed, one feed and one a wild relative. Bearing in mind the large distances corn/maize pollen is known to travel, it is inevitable that contamination will occur. The report details contaminated corn/maize seed found in eleven countries in the decade: Austria, Chile, Croatia, France, Germany, Greece, Italy, New Zealand, Slovenia, Switzerland and the US. Documented seed contamination events in NZ alone took place in 2000, 2002, 2003, 2004 and 2006. The October/November 2006 incident were originally thought to involve 800 kilograms of seed, but that figure eventually rose to 4420 kilograms. Sweet corn crops grown from the Syngenta seed in the Gisborne and Hawkes Bay regions were to be destroyed. Details of the transgene construct were not made available.[17]
- The Japan Times (14 December 2004) reported that, despite strict handling protocols, transgenic corn/maize and soybean plants have been found growing wild near Shimizu port, Japan, and GE canola/rapeseed near Fukuoka's Hakata port. It is suspected that the seed was spilled during transport. The discovery of the GE rapeseed follows its detection at six other ports.
- Careful border surveillance is required to maintain the local harvest in a state acceptable to trading partners.

Are GE crops profitable?

Yes, for developers. Time has proven that farmers generally do not benefit over the longer term.

Genetic engineering and Centres of Origin

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[16] See www.greenpeace.org/raw/content/international/press/reports/gm-contamination-register-2007.pdf; www.gmcontaminationregister.org.

[17] Greenpeace 2007 Report www.greenpeace.hu/up_files/1171551710ge_contamination_report_07.pdf; www.gmcontaminationregister.org

What are 'centres of origin'?

Centres of origin or centres of diversity are simply the place where a food plant originated. For example, Mexico for corn/maize; Central America for maize, the tomato and cacao; the US for the sunflower; Asia for rice; China for soybeans; the Andes for potatoes; Ethiopia for coffee; Africa for sorghum and yams; the Middle East for wheat, dates, barley and pulses/legumes.

Farmers, largely in developing regions, have been responsible for cultivating community-bred varieties, known as landraces. These varieties have led, for example, to the potato being grown on land below sea level or high in the Himalayas. One rice variety grows in 7.5 metres of water, while another grows in 60 cm of annual rainfall.

Closely related species that survive in the wild are known as wild relatives.

Landraces and wild relatives are rich repositories of crop genetic diversity and provide genes to improve yield, quality, and resistance to pest and disease.

Indigenous peoples have developed the yields and quality of these natural food crops over millennia. Saving and sharing seed is a traditional right. These traditional practices provide a legacy of seed stock. The knowledge gained from these practices is usually passed from generation to generation orally rather than in writing. The term 'Prior Art' is how this knowledge may be recognised by international legal systems for granting patents. In practice, such knowledge has generally been disregarded and the knowledge simply pirated by international commercial and industrial interests.

High-yielding, elite cultivars depend on new germplasm from native species. Canadian researchers estimate that between 1976 and 1980, wild species added US$340 million annually in yield and disease-resistance to the US farm economy. For example, genes selected from a single wild tomato species grown in Peru, contributed US$8 million/pa to US tomato processors. (See the Global Biodiversity Assessment, p. 468.)

Industrial agriculture has been responsible for substantial declines in biodiversity worldwide. Today, over fifty percent of staple food crops are grown from seed marketed by ten corporations that include the transnational biotechnology corporations Bayer, Monsanto, Dupont, Dow, and Syngenta (previously Novartis). Monsanto controls over 70% of the genetically engineered seed market.

Rice and soybeans

Asia is the centre of origin of an uncountable number of varieties of rice and soybeans.

China, the centre of origin of soybeans and home to over 90 percent of Earth's wild soybean resources, is now the world's largest importer of the crop. In 2000, it imported over nine million tonnes, the equivalent of 177 percent of the country's annual production. In 2006, imports reached over 28.6 million tonnes. Liu Chaoyang, an analyst with the Southern Fund Management Co. Ltd, has said that such substantial soybean imports threaten China's grain security. The National Grain and Oil Information Centre estimated soybean production nationwide at less than 13 million tonnes for 2007, down 12.32 percent from 2006; the reason for the decline attributed to the impact from genetically engineered produce from abroad. Compared to transgenic soy, China's soybeans are disadvantaged in cost.

In February 2003, its National Grain and Oil Information Centre announced that China had designated three provinces and northern Inner Mongolia for producing non-GE soybeans. This would be sufficient to meet the home market demand of around 33 million tonnes in 2007 and protect native species. Import figures show this target had not been met.

The 'Conservation and Sustainable Utilization of Wild Relatives of Crops in China' Project was expected to begin in May 2008 and to last six years. Project 00053198 is to focus on eliminating threats and their root causes to the conservation of wild relatives of rice, wheat and soybean in their natural habitats at one site in each of eight provinces representing a diverse range of ecological and socio-economic conditions. The best practices will be replicated in another 50 counties to promote sustainability of wild relatives of crops in China. Three sites are earmarked for the wild relatives of soybean in their natural habitats. Currently, China has conserved over 23,000 cultivars of soybean germplasm and more than 7000 wild soybeans.[18]

Potatoes

The Andean mountains are home to many thousands of native varieties of potato. The government of the Peruvian region, Cusco, is to ban all transgenic varieties of potato to ensure that genes from GE potatoes do not contaminate native potato varieties. (www.grain.org.)

Wheat, barley, dates, pulses/legumes

Iraq is part of the 'Golden Crescent' that runs from Palestine and Jordan, to southeast Turkey, northern Iraq and western Iran. This crescent is the centre of origin of a number of food plants: e.g. barley, dates and pulses/legumes. It is also the birthplace of the ancestor of most varieties of cultivated wheat, wild emmer, a tetraploid. Uncounted local varieties of grains and pulses/legumes, developed by traditional methods over millennia, are resistant to the desert conditions of that area. In 2002, the UN Food and Agriculture Organization (FAO) estimated that 97 percent of Iraqi farmers saved seed from their own stocks or purchased seed from local markets.

[18] See United Nations Development Programme, www.undp.org.cn; the International Institute for Environment and Development (IIED), London; Nature, 18 July 2007; www.chinaview.cn, 6 March 2008.

After the cessation of the hostilities that began in 2003, an early piece of legislation introduced in Iraq was the 'Order 81 patents, industrial design, undisclosed information, integrated circuits and plant variety' law, issued on 26 April 2004. L Paul Bremer, chief of the occupation authority in Iraq, issued it during the "transfer of sovereignty" and in 2008, it is reported to be functioning as binding law. (http://www.celsias.com/2008/03/19/.)

A joint report from GRAIN and Focus on the Global South claims Order 81 has made it illegal for Iraqi farmers to re-use seeds harvested from new varieties registered under the law. While it does not make it illegal for Iraqis to use traditional seed stocks already saved, the reality is that the devastation caused by drought and war makes holding onto stored seeds more difficult, and given time it is believed that the seeds will disappear. A new seed market will emerge where, every cropping season, Iraqi farmers will have to purchase seeds from transnational corporations like Monsanto. Corporate dependency will come about because Order 81 only allows "plant variety protected" (PVP) planting materials to enter the Iraqi market. PVP plants are patented, and must be "new, distinct, uniform and stable." These plants are owned by their creators, international corporations, and they enter the Iraqi market place with a two-decade monopoly on crop varieties and a 25-year monopoly on trees and vines. During these periods, it will be illegal for Iraqi farmers to save and re-plant PVP seeds.

Order 81 allows patenting of biologic material, including genetically engineered (transgenic) material. This contravenes the UN Millennium Forum Declaration.[19]

Corn/maize

Mexico is the centre of origin of corn/maize. Prior to the introduction of the North American Free Trade Agreement (NAFTA), Mexico grew enough corn/maize for its domestic use and exported the remainder. Today, it imports corn/maize from the US and, as of January 2008, US corn/maize and bean imports into Mexico from the US are no longer subjected to any tariffs. Because US corn growers receive subsidies, they are able to sell corn/maize to Mexico at prices that have made it uneconomical for Mexican farmers to grow the crop. In the first 13 years of NAFTA being in place, some six million farmers are reported to have left rural land.

Mexico remains the fourth largest producer of corn/maize worldwide at approximately 20 million tonnes per annum, but this is small in comparison to the estimated 270 million tonnes estimated to be grown in the 2007 US season. The US crop meets about 70% of the demand worldwide.

It is claimed that one third of the US corn/maize acreage is grown from genetically engineered seed and some of this transgenic crop is imported into Mexico. The simple act of

[19] www.iraqcoalition.org/regulations; www.naomiklein.org.

seed falling off haulage trucks has been blamed for contamination of native landraces, corn/maize varieties that are the origin of commercially grown corn/maize.[20]

What about genetic diversity?

Earth's rich diversity is disappearing. The Food and Agriculture Organization of the United Nations, the FAO, estimates that since the beginning of the twentieth century, around 75 percent of the genetic diversity of agricultural crops has been lost. The term 'genetic erosion' describes this loss of genetic diversity between and within populations of the same species.

In its report entitled, 'State of the World Report on Plant Genetic Resources,' the FAO identified genetic erosion as a serious problem. For example, its says that in China nearly 10,000 wheat varieties were cultivated in 1949; by the 1970s, only about 1000 (p.22). In Mexico, genetic erosion of corn/maize is well documented. Of the varieties in Mexico in 1930, only 20 percent remain (p.22).

The primary reason for the loss of crop genetic diversity is that commercial, uniform varieties are replacing traditional varieties, especially in the centres of origin or diversity, like Mexico. When farmers abandon their community-bred varieties to plant new ones, the old varieties become extinct.

The introduction of commercially developed, high-yielding grains began in the 1950s. The acceptance and spread of these new varieties was rapid and, by 1990, for example, they were grown on half of all wheat lands and over half of all rice lands. New, genetically uniform cultivars replaced community-bred varieties.

The erosion of crop genetic diversity threatens the existence and stability of the world's food supply. Available diversity is vital for the maintenance and improvement of new crop varieties: e.g. to maintain pest and disease resistance; and to develop traits like drought tolerance. Industrial agriculture's high-yielding, elite cultivars depend on new, exotic germplasm.

Are there dangers in growing crops that are genetically uniform?

Industrialized agriculture favours genetic uniformity. Vast areas are typically planted in a single, high-yielding variety or a handful of genetically similar cultivars. Such uniform crops are more vulnerable to epidemics of pests and diseases.

The Irish Potato Famine of the 1840s is an example of the dangers of genetic uniformity. When potatoes were introduced into Europe from South America in the 1500s, none of the introduced varieties was resistant to a fungus that struck Ireland's potato crop in the 1840s. It

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[20] See 'Farmers Call for Suspension of Seed Treaty, 1 November 2007, ETC Group; http://www.counterpunch.org/ross11212007.html.

wiped out the crop and one and a half million people died in the resulting famine. The potato blight, in new and more virulent forms, poses a threat to food security today.

In 1970, over 80 percent of commercial corn/maize varieties grown in the US carried a gene that made them genetically susceptible to southern leaf blight. That year, this genetic uniformity was responsible for destroying almost one billion dollars worth of the annual crop, reducing yields by up to half.

In the 1984 dry season in the Philippines, two rice varieties developed by the International Rice Research Institute (IRRI) covered about 90 percent of the rice-growing area. Such intensive cultivation of fewer varieties has led to rice diseases and pests growing in number, intensity and geographic distribution.

What about food security?

Genetic diversity is the key to food security and sustainable agriculture. Sixty 60 percent of agricultural land is estimated to still be farmed by traditional or subsistence farmers, mostly in marginal areas. Marginal farming areas tend to be rich in plant and animal genetic diversity and traditional knowledge. Ultimately, farming communities hold the key to conservation and the use of agricultural biodiversity, and to food security for millions, particularly in poor areas. Long term, the conservation of plant genetic diversity and food security depends on protecting centres of origin, centres of diversity.

How can we protect centres of origin and diversity?

Historically, there has been free access to plant genetic diversity. Control, ownership and access to plant genetic diversity has, over the past two decades, become a free-for-all. Who can patent the most, soonest? Much of the development, collection and storage of plant materials is in the North, in laboratories and gene banks established by the International Research Centres under the aegis of the Consultative Group on International Agricultural Research (CGIAR). In this, the 21st century, plant breeding, agricultural biotechnology, and commercial seed sales are dominated by a handful of transnational seed and agrichemical corporations like Monsanto, Bayer, Dupont, Dow, and Syngenta (previously Novartis).

The FAO's role has been to give prominence and visibility to the critical social and economic importance of agricultural biodiversity. Staying GE-free and reducing the use of agri-chemicals would help protect genetic diversity.

Seed banks – will they be a safety net?

The UN Food and Agriculture Organization believe the threat to native seed varieties is "acute." It is helping to fund the construction of a seed storage vault on a remote island in the Svalbard island group, northern Norway, almost 1300 kilometres from the North Pole. Investors include the Gates Foundation, the Rockefeller Foundation, Monsanto Corporation, Syngenta Foundation and the Government of Norway. The Svalbard Global Seed Vault will contain up to three million different varieties of seeds from the entire world. The Norwegian government say this will ensure "that crop diversity can be conserved for the future."

Iraq's national seed bank was in Abu Ghraib, Baghdad. It was destroyed during the 2003 hostilities, but Iraqi scientists had previously sent a box of heritage seeds to the International Centre for Agricultural Research in Dry Areas (ICARDA) in Aleppo, Syria. Adel El-Beltagy, director-general of ICARDA, believes that the contents of the box "will form the basis for plant breeding to restore Iraqi agriculture and end the country's reliance on food aid. The box also has a global importance, as among the seeds are varieties of crops with inbuilt resistance to extreme heat, drought and salinity. These could be invaluable for plant breeding programmes worldwide in the coming century."

Whether this will be a true 'safety net' remains to be proven. Cambodia lost most of its species of native rice when Pol Pot brought in Chinese varieties, even though the imported varieties produced poorly and resulted in famine. Some native Cambodian rice species did not recover.

Scientists acknowledge that heritage seeds tend to become extremely rare or even extinct when introduced varieties are grown. Protecting native species of staple food plants is crucial.

Genetic engineering and trees

Can trees be genetically engineered?

Genetic engineering technology is being increasingly used in forestry experimentation. This has led to transgenic tree planting in at least 35 countries. In some cases, the research is confined to laboratories, but millions of transgenic trees have been grown in field trials in China, North America, Australia, Europe and India and, to a lesser extent, South America and Africa. It is claimed that, in some countries, record keeping is inadequate and there are plantations where no monitoring is carried out. This is particularly reported as happening in China.

What trees are engineered?

Transgenic tree species include Populus (about 47% of experiments), Pinus (19%), Eucalyptus (7%), Spruce (picea), Ulmus, Larix, Casuarina, Betula, Liquidamber and others. Developed traits include herbicide resistance and lignin content.

GE trees have been widely planted in open trials and major plantations of forest trees have been developed.[21]

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[21] FAO 2004, Preliminary review of biotechnology in forestry, including genetic modification. Forest Genetic Resources Working Paper FGR/59E. Rome. Available at: www.fao.org/docrep/008/ae574e/ae574e00.htm;

How are GE trees created?

Transgenic trees are created using variations of genetic engineering technology.

One recent development uses carbon nanofibres to inject synthetic DNA into plant cells. (Nanofibres are comprised of particles whose size is only a few times that of molecules. One nanometre is a billionth of a metre.) This technique involves the growth of carbon nanofibres on silicon chips. The fibres have strands of DNA attached. Living cells are thrown against them and pierced by the fibres, thus injecting DNA into the cells of a new host. The synthetic DNA can then lead to the expression of new proteins and traits in the host cells. (Nanoparticles are themselves potentially hazardous. There are uncertainties about their potential effects on human health and the environment.)[22]

Would GE trees cause environmental problems?

Questions and projections based on science include the following:

- Introduced genes can be unpredictable; unforeseen traits can develop and be passed on to future generations. Where gene stacking is used – introducing multiple genetically engineered traits into a new host – it cannot be predicted how stable each gene will be, or how predictable or stable the development of the combination of genes will be.
- What environmental impact will there be if we replace diverse native forests with monoculture tree plantations? Transgenic trees could impact on local flora and fauna in ways that cannot be adequately predicted. Trees that do not flower and fruit cannot provide food for the insects, birds and mammals that feed on pollen, nectar, seed and fruit, and thus local flora could lose the variety of pollinating insects normally attracted to an area. This would inevitably have huge impacts on biodiversity, particularly in large areas of monoculture forests.
- Could transgenic trees be contained to protect surrounding flora? Pollen from GE trees has been found to travel long distances. For example, a study undertaken in India established that pollen from pine trees travelled over 600 kilometres (Sing et al, 1993). Transgenic trees and their introduced DNA could become untraceable unless stringent control and monitoring is carried out; this has happened in China.
- Will GE trees affect humans living in the area? The full impact of monoculture plantations on indigenous people can be catastrophic as has been seen in South America where some transgenic trees are being grown. Any monoculture crop adversely affects the diversity of flora and fauna in an area.[23]

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www.i-sis.org.uk/UNCaution.php 'A Concept to Engineer Male Reproductive Sterility in Conifers,' Walter, C; www.isb.vt.edu/news/2006/artspdf/jun0601.pdf;www.isb.vt.edu/news/2006/news06.jun.htm#jun0601.

[22] 'Nanotubes highly toxic,' SiS 22; 'Nanotox,' SiS 21.

[23] 'GM trees the ultimate threat.' SiS 26.

Why grow GE trees?

Trees have been genetically engineered with the aim of producing faster growing trees, to control pests, to absorb soil mercury from contaminated sites, to alter seed and flowering production, to increase productivity for timber and pulp, and for reducing the fibrous content of trees (lignin) which affects wood strength.

The UN's Food and Agriculture Organization surveyed 65 countries involved in transgenic forestry experiments. Over four hundred questionnaires were mailed and 49 countries responded. The respondents saw consumer rejection, and the cost of trials, intellectual property rights and regulations, as obstacles to their research.

The benefits of transgenic trees were seen as easier pulping methods and reduced use of chemicals for the timber industry, pest and disease resistance, phyto-remediation of mercury in soil, secondary compounds to pharmaceuticals, and the potential to withstand extreme environmental conditions such as drought, heat and cold. These perceived benefits could require years of biological and environmental assessment before commercialisation is practical.

A final conclusion of the survey responses was that traditional forestry biotechnology - i.e. research and development that excluded genetic engineering technology - is less costly and requires less regulation.

The UN's Food and Agriculture Organization (FAO) proposed safety assessment framework for transgenic trees must acknowledge the diversity of existing forests and recognize the benefits of multiple uses of forests that conserve diversity.[24]

Which countries are growing GE trees and why?

More than half the development work on transgenic trees and about 80% of trials have taken place in the US, and the US Department of Energy has sequenced the genome of the poplar tree.

China was the first country to release transgenic trees commercially. Its Chinese State Forestry Bureau is unable to trace all of the 1.4 million GE poplars (Populus nigra) it planted. Field trials are progressing with Poplars engineered to be infertile and pest resistant. Plans to increase plantations of GE trees in China are being considered.[25]

Chile may be the first country in South America to market transgenic trees. Huge monoculture plantations are being grown there, as well as in Uruguay and Argentina. This type of economic development is founded on the exploitation and destruction of natural resources.

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[24] Multiple uses of forests SiS 25; www.wrm.org.uy/plantaciones/RECOMA.html.

[25] GM trees lost in China's forests,' SiS 25.

Transgenics are seen as a means to improve competitive capacity. In Chile, GenFor is working on transgenic pine (Pinus radiata) engineered with a Bacillus thuringiensis or Bt gene. GenFor is also working to engineer loblolly pine (Pinus taeda), native to the southeastern US, to increase the cellulose and lessen the lignin in the wood.

The database of knowledge about genes, gained from research in the last few decades, is also being used. Reports claim that at least half a million Chilean hectares are under-utilized because of the intense cold in the pre-cordillera Andes area. Its Instituto Forestal (INFOR) and a group of forestry companies are working with conventional genetic selection to produce a cold-resistant Eucalyptus globulus. In the south of Chile, the Universidad de la Frontera is studying genes from a grass that survives in the Antarctic (Deschampsia antartica) with the idea of producing cold-resistant trees.

Has New Zealand planted GE trees?

New Zealand's forests of Pinus radiata have been developed over many decades using highly efficient, selective breeding. The returns are a major export earner.

A field trial involving pine trees genetically engineered to grow faster, produce better wood, and for resistance to diseases and pests, is taking place. The research is funded by New Zealand's Foundation for Research, Science and Technology.

The New Zealand Forest Research Institute at Rotorua says security measures to stop cross-pollination include a buffer zone around the pine trees.

Scion - the State owned enterprise undertaking the research on the transgenic trees - has been accused by observers of negligent reporting. The auditor, MAF Biosecurity New Zealand, and the Environmental Risk Management Authority (ERMA), are accused of being complicit in the negligence. Scion has claimed that all the trees in one tree experiment were healthy and growing normally, when photographs available to New Zealand's Soil & Health Association showed that was not necessarily so. Some trees showed significant die-back. Steffan Browning of Soil & Health, said: "The other tree experiment reported does not claim normal growth and photographs show abnormal growth."

Among other complaints, Scion has been accused of not pruning all trees according to the approval conditions and of potentially transporting transgenic plant material on mowing equipment to other research and forest areas, and thus the wider environment. Scion's acting chief executive Elspeth MacRae has claimed that the genes involved in the research pose no danger to the outside environment because the genes were sourced from naturally occurring New Zealand organisms.

PSGR Trustee, Dr Elvira Dommisse, a geneticist, speaking on the genetic engineering of pine trees, has stated:

"That does not mean that the same gene which has been genetically engineered into another species in an artificial gene construction will be harmless. It is in part true, but we cannot conclude from this that all is well. In its genetically engineered form, the gene is no longer under the control of its own DNA. It may well be a synthetic modified version of the original gene and is jammed into a complicated construct made up of bits of DNA from a number of different organisms. This means the gene is always switched on and is engineered to produce large amounts of a protein or proteins that pine trees don't normally make. The cellular machinery of a pine tree may produce a protein or proteins that are different from those used in the GE process. Such altered proteins can be harmful. This has already happened in genetically engineered peas, when a harmless bean protein became a toxin when engineered into the closely related pea."[26]

Are safety tests being done?

Safety testing of anything produced using genetic engineering technology is generally left to the developer. Only a handful of independent tests have been carried out. There is a very urgent need for independent oversight and safety testing of all GE experimentation.

Pierre Sigaud is an expert in forest genetics who works for the FAO, the UN's Food and Agriculture Organization. He has warned against rushing into growing GE trees commercially before running environmental risk assessments according to national and international protocols. Sigaud stated

> "The issue goes beyond country level since pollen flow and seed dispersal do not take account of national boundaries and wood is a global commodity."[27]

Are regulations in place?

The first international law to control transportation of LMOs (Living Modified Organisms, which covers GEOs/GMOs, transgenic organisms) was set in place by the Cartagena Protocol on Biosafety. It is designed to control the movement of transgenic organisms across national boundaries, ecosystems and environments, and health and economic risks. This includes threats to natural forests that are crucial in stabilising climate and regulating rainfall.

Individual countries can set their own protocols and regulations within their borders. Few countries do have regulations, and no regulations are seen as stringent enough to control the release of transgenic trees.

[26] Soil & Health www.organicnz.org, Scion Annual Report to ERMA, 2007 Annual Report GMF99001 & GMF99005 [Public version]; Organic NZ 'Failure in GE Tree Reporting May Bring Tears To Crop & Food's Onion Trial' 5 February 2008; 'Rotorua GE Tree Trial remains an environmental threat' 16 March 2008, 'GE Tree trial breach shows institutional contradictions' 16 January 2008, 'Christmas is over Scion, take the GE trees down' 13 January 2008; Hawkes Bay Today, 16 and 19 January 2008.

[27] FAO. 2004. Preliminary review of biotechnology in forestry, including genetic modification. Forest Genetic Resources Working Paper FGR/59E. Rome. Available at: www.fao.org/docrep/008/ae574e/ae574e00.htm; www.i-sis.org.uk/UNCaution.php, ISIS Press Release 12/10/05, UN Cautions Over GM trees.

Of concern, are approvals such as that outlined in an ISIS Press Release (17 August 2007). It accused the USDA of "rubberstamping the largest ever collection of transgenic poplars with uncharacterised and dangerous constructs." The US Department of Agriculture's Animal and Plant Health Inspection Service (APHIS) prepared an Environmental Assessment in response to permit application (06-250-01r) received from Oregon State University for field-tests of GE Populus alba and Populus hybrids in small plots on a 320-acre open site. These plots included trials for reproductive sterility, gibberellin (GA) metabolism, reporter gene constructs and 'activation tagging' mutants, and trees that would not be allowed to flower.

Even where regulations exist, their enforcement is often inadequate, meeting commercial rather than public interests.[28]

Is there a moratorium on GE trees?

No, there is no international moratorium on transgenic trees.

Commercial interests want to grow GE trees in large-scale, monoculture plantations and there has been on-going pressure from governments, indigenous peoples, and environmental organizations not to allow this to happen, to have in place a global moratorium on growing transgenic trees.

At the Cartagena Protocol on Biosafety meeting, held in Montreal early in 2005, and at the United Nations Forest Forum in 2004, delegates lobbied hard for a moratorium on GM trees. The UN's Food & Agriculture Organisation (FAO) says it wants an international framework so that the safety of transgenic trees can be assessed.

At the United Nation's Convention on Biological Diversity (CBD) in Curitiba, Brazil, in March 2006, a formal declaration was passed to recognize the threats posed by GE trees. It urged all countries to approach the technology with caution. This declaration supported the FAO's 2005 call for an international framework to assess the safety of GM trees.

In May 2008, the member countries of the CBD did not reach an international agreement. Under the decision, members can ban GE trees in their own countries. However, such a moratorium would not protect a country from pollen being blown across borders and contaminating native or commercial species.[29]

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[28] Prof. Joe Cummins and (Dr Mae-Wan Ho, Docket APHIS-2007-0018, www.regulations.gov/fdmspublic/component/main; www.i-sis.org.uk/GE-trees.php; www.i-sis.org.uk/GMpoplarsandhybrids.php.

[29] UK Telegraph, Ban decision could mean GM trees in the wild, Alice Klein www.telegraph.co.uk/earth/main.jhtml?xml=/earth/2008/05/30/eagm130.xml.
ISIS Press Release, 30 May 2006, UN Convention Recognises GM Tree Threat. Why there should be a moratorium on GM trees, Sam Burcher; 'Why there must be a moratorium on commercialisation of GM trees, Sam Burcher, 12 October 2005.

Could GE trees adversely affect people?

Yes. Growing eucalyptus trees in Rio Grande do Sul, Brazil, has raised protests against the serious social and environmental impact caused by the expansion of plantings called the 'green desert' - huge eucalyptus monocultures spreading across southern Brazil. Indigenous peoples are having to fight for land rights and access to land, and defend their right to water, biodiversity, soils, foods, medicines, fuel, etc. that come from the land, and struggle for autonomy and self-determination.

The expansion of monoculture tree plantations also continues in Chile, Argentina and Uruguay. Timber and pulp mills, other service industries, and road and rail networks, have had to be established to support these plantations. These in turn increase the impact on environments and populations.

In the decades ahead, when the trees have been felled, the soil is likely to be seriously depleted and potentially useless for a return to traditional agricultural usages.

Monoculture plantations operated by transnational corporations are disenfranchising local peoples in support of corporate profits, and the developments include input by International Financial Institutions such as the World Bank, the Inter-American Development Bank, the Asian Development Bank, and commercial banks, and organizations such as the United Nations Food and Agriculture Organization, and forestry consulting firms. All are supported by national governments.[30]

Genetic engineering and terminator trees

What are 'terminator' trees?

The US Department of Agriculture and the Delta & Pine Land Company developed terminator technology; trees genetically engineered to produce sterile second-generation seeds. It is not available commercially.

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http://www.rightoncanada.ca/c.juIZLdMOJrE/b.2517563/siteapps/advocacy/ActionItem.aspx?c=juIZLdMOJrE&b=2517563&aid=10325.

[30] The Vitoria Statement in Support of the Struggles of Local Peoples Against Large-Scale Tree Plantations. WRM Bulletin No. 101, www.wrm.org.uy/bulletin/101/Vitoria.html, December 2005 [Vitoria is in Espirito Santo, Brazil]; www.bioplanet.net; 'Voices in the Green Desert,' Silvia Ribeiro; Orin Langelle and Anne Petermann, 'Global Justice Ecology Project' and 'GM Trees and Indigenous Rights'; www.fundacionredbio.org; www.grain.org/seedling/?id=429; www.australtemuco.cl/prontus4_noticias/site/edic/2004_06_08_1/home/home.html; www.grain.org/seedling_files/seed-06-07-3.pdf; the World Rainforest Movement, FASE-ES and Global Justice Ecology Project; www.grain.org/seedling/?id=428; www.grain.org/seedling_files/seed-06-07-2.pdf.)

Terminator technology is one form of Genetic Use Restriction Technologies or GURT, of which there are conceptually two types.

- V-GURT, which produces sterile seeds. A grower purchasing seeds containing v-GURT technology could not save the seed from the crop for future planting. V-GURT technology is restricted at plant variety level.
- T-GURT, which engineers a crop plant to function only when a proprietary chemical is applied. Farmers can save seed for the next season's planting, but do not get the enhanced trait in the crop unless they purchase the activator chemical compound. The technology is restricted at trait level.

Are there any advantages to using terminator technology?

Most scientists dismiss the claims that terminator technology is an incentive to the development of new plant varieties, and would improve farm management, grain quality and biosafety. They claim the disadvantages are:

- The potential transmission of the terminator trait to cultivated plants, particularly those whose seeds are saved, or to wild plants;
- The questionable safety of food produced from GURT crops;
- The unequal and unfair distribution of means and the targeting of vulnerable populations; saving seed for next season's crop is accepted as a traditional right.
- The presumption of entitlement by developers;
- The undermining of food security.

Does the technology work? Is it safe?

Researchers have found that the dispersal or gene flow of pollen and seeds from forest trees can be measured in kilometres, and potentially hundreds or thousands of kilometres. Once released, transgenes from transgenic trees cannot be contained and pose serious threats to forest ecosystems. Developers believe the solution is 'terminator' techniques that prevent flowering or pollen production.

In terminator trees, anti-sense genes or small regulatory RNA prevent active gene products from being formed. Also employed is a kind of genetic abortion using a 'suicide' gene. This could be the barnase ribonuclease gene from the soil bacterium Bacillus amylolquefaciens, which is controlled by a promoter specific to floral or pollen development. Once activated, the gene product kills the cells in which the gene is expressed.

Scientists at Sopanen University, Finland, have studied the control of flowering in silver birch trees, using a flower specific birch promoter gene, BpMADS1, to drive the barnase gene. They found that floral cell ablation prevented flowering, but that this had side effects to leaves and branching. These side effects may have been a pleiotropic effect of the gene insertion and the pleiotropic effects seen may extend into areas not yet detected.[31]

Are terminator trees realistic? Practical? Desirable?

There are many reasons why they are none of these things, among which are the following major concerns.

- Trees that do not flower and fruit cannot provide food for the insects, birds and mammals that feed on pollen, nectar, seed and fruit. Local flora would thus lose pollinating insects. This would inevitably have huge impacts on biodiversity, particularly in large areas of monoculture forests.
- Pleiotropic effects from the gene insertion may be immediately seen or may extend into areas not easily detected. For example, we have little knowledge of how these effects would affect soil bacteria.
- It would need a failure rate of only part of a percent for transgenes to contaminate other trees, potentially at large distances, in ways that could not easily be monitored.

Is 'terminator' technology dangerous?

The majority of scientists and members of the public believe it is.

- The ablation toxins used in creating sterile trees present dangers: e.g. barnase ribonuclease has proved toxic to the kidneys in rats; and barnase was cytotoxic in mice and human cell lines.
- Even if totally sterile, terminator trees can spread by asexual means. The genes can spread horizontally to soil bacteria, fungi and other organisms in the extensive root system of the forest trees, which in turn could have unpredictable impacts on the soil biota and fertility.
- There is the potential, however slight, that terminator genes could spread horizontally to other forest trees, also making those infertile.
- Transgenic traits tend to be unstable. They can break down, revert to flower-development, and spread transgenes to native trees. They could create pollen that poisons bees and other pollinators as well as causing potential harm to human beings.
- Sterile monocultures are known to yield more readily to disease or senescence, which in turn has the potential to devastate entire plantations over huge areas.
- Preventing sexual reproduction radically reduces genetic recombination, which generates genetic diversity and evolutionary novelty in nature.[32]

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31 See The Institute of Science in Society (ISIS) Press Release, 2 March 2005, Terminator Trees.

32 See www.gefreeseeds.com; The NZ Herald, 29 May 2006, www.nzherald.co.nz/topic/story.cfm?c_id=220&ObjectID=10383921; http://www.esr.cri.nz/competencies/populationhealth/genetransfer.htm.

Are 'terminator' trees regulated?

Testing of transgenic developments is almost always inadequate, with a reliance on industry/developer test results, and oversight of field trials is almost always scant or non-existent.

For example, Application No. 06-325-111r from ArborGen LLC was made to the US Department of Agriculture's Animal and Plant Health Inspection Service (APHIS). It sought approval to continue field-testing transgenic Eucalyptus trees that may flower. The trees were cloned from a hybrid of Eucalyptus grandis X Eucalyptus urophylla, and engineered with three gene constructs; two that confer cold tolerance, one to reduce flower development. This field test was originally planted under APHIS Notification 05-256-03r, a permit for Eucalyptus grandis, not the hybrid given on the current Application 06-325-111r. Therefore, is the Application to "continue field testing" valid? In July 2006, ArborGen, having been charged with failure to maintain the identity of trees in their test plots, were directed to remove the trees, and US Federal Courts have ruled against the USDA in three cases for failing to carry out proper environment impact assessment, thus making the original approvals illegal.

Where can I learn more about GE trees?

1. A Silent Forest: The Growing Threat, Genetically Engineered Trees,' is narrated by Dr David Suzuki. This documentary discusses the threats posed by transgenic trees to our environment and to human health.[33]
2. ISB News Report, June 2006, covering agricultural and environmental biotechnology developments, a concept to engineer male reproductive sterility in conifers, Christian Walter.[34]
3. http://lists.stopgetrees.org.
4. www.stopgetrees.org The STOP Genetically Engineered Trees Campaign.
5. www.globaljusticeecology.org Global Justice Ecology Project.
6. www.globalforestcoalition.org Global Forest Coalition
7. http://forests.org/

Genetic engineering & xenotransplantation

What is xenotransplantation?

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[33] Professor Emeritus, David Suzuki, is an internationally respected geneticist, an award-winning broadcaster, the author of 43 books, and recognized as a world leader in sustainable ecology.

[34] www.isb.vt.edu/news/2006/artspdf/jun0601.pdf and www.isb.vt.edu/news/2006/news06.jun.htm#jun0601.

Xenotransplantation is the transplantation or implantation of live cells, tissues or organs across species barriers - e.g. from animals to humans or humans to animals - by artificial means.

'Xenotransplantation' is a single description for xenotransplantation and any related technologies, unless otherwise stated. N.B. Allotransplantation is the transplantation of organs between members of the same species, e.g. human to human.

While xenotransplantation does not per se involve genetic engineering, it has many points in common with the biosafety issues related to genetically engineered organisms. Further, it does not exclude genetic manipulation(s) of the transplanted cells or tissues whether of human or non-human origin.

The ethical issue of individual benefit versus societal risk demands a different approach from that usually taken in the evaluation of new medical technologies. With clinical xenotransplantation, medical science can be claimed to be using short-term solutions and not recognizing or acknowledging the long-term consequences.

All organisms have complex inter-relationships about which we have little knowledge, and the timescale for important biological phenomena can be much longer than ordinary 'human' time. Xenotransplantation breaches species barriers that have evolved over billions of years and creates real possibilities of new diseases entering the human population.

Xenotransplanted cells, their hosts and the products of these cells should be kept strictly isolated from the common biological environment, including the human environment. Only fully confined experimentation is acceptable and the ethics of xenotransplantation cannot be debated without consideration of the science and its consequences.

PSGR does not advocate nor support the free therapeutic use of transplantation of animal components to human recipients in the state of current and foreseeable scientific uncertainty.

With the expansion of genetic engineering biotechnology research, conventional research has been grossly under-funded. Patents associated with this development have also restricted or inhibited much valuable research. PSRG believes the adoption of xenotransplantation will add to this dilemma to the detriment of society.

For more detailed information, we refer you to the PSRG submission to the New Zealand Bioethics Council on Xenotransplantation.[35]

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[35] PSRG. 2005 Xenotransplantation submission to the Bioethics Council 19-5-05 https://psgr.org.nz/pub-res/submissions/general-government/39-submission-on-xenotransplantation?highlight=WyJ4ZW5vdHJhbnNwbGFudGF0aW9uIiwiJ3hlbm90cmFuc3BsYW50YXRpb24nIl0=