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Genetically modified trees: Chapter 2

By Chris Lang, published by WRM and FoEI, December 2004

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2: Unravelling the lies: Why GM trees don't make sense

Proponents of genetically modified trees try to convince others that the research into GM trees is a neutral technology developed by scientists to solve some of the world's problems. They put forward a series of arguments which deflect attention from the problems associated with GM trees and industrial models of forestry, including monoculture tree plantations.

Steven Strauss is a professor of molecular and cellular biology and of genetics at the Department of Forest Science at Oregon State University. He is one of the world's leading researchers into GM trees. In 2001, Strauss and colleagues at the Oxford Forestry Institute wrote that discussions about GM trees tend to be "highly polarized":

> "In debate, the arguments often shade from biological to ideological, depending on the worldview of the participant. Those against intensive management for wood production, who feel genetic modification is unacceptably unnatural or who object to the highly patent-intensive and thus corporate role in genetic modification, tend to dislike it. Those who believe that growing more wood on less land is an important environmental as well as economic goal, and who accept a continuing major role for technology and large corporations in forestry and agriculture, tend to favor it."[37]

This statement also reveals much about Strauss' worldview and that of his middle-class, male, Northern, highly qualified colleagues. This is a worldview that has little in common with the reality faced by villagers who have lost land and livelihoods to massive industrial tree plantations in the Global South. Or with plantation workers who have seen their co-workers and friends poisoned by the excessive amount of pesticides they have to spray on the plantations. Or with workers who produce charcoal from eucalyptus in horrific conditions in Brazil.

The arguments in favour of GM trees do not address the concerns of villagers living near plantations. Neither are the arguments aimed at anyone who has ever listened to villagers describing their problems since a pulp and paper firm covered their land with a monoculture tree plantation. Instead, GM proponent's arguments are aimed at poorly

informed readers who have never seen a monoculture industrial tree plantation, or if they have, then it was with officials from the firm managing the plantation.

GM tree proponents never discuss land rights, or the rights of local communities to manage their own resources. They do not talk about reducing demand for timber products, such as paper, or the fact that the demand is largely from the North. Their arguments are aimed at deflecting attention from these issues.

1. Faster growing GM trees will not help take pressure off native forests

The argument that planting faster growing GM trees means "growing more wood on less land" appears at a first glance to be convincing. GM tree proponents argue that since world demand for timber products is rising, if more wood is produced in faster-growing GM tree plantations then less will need to be cut in native forests.[38]

However, this overlooks the reality of establishing plantations, particularly in the South. Industrial tree plantations and pulp mills provide few jobs, but destroy local livelihoods. People are forced to move away, including to new forests where they clear land for farming.

Tree plantations are often established after native forests have been destroyed. In Sumatra, for example, vast areas of forests have been cleared to feed pulp and paper mills. To replace the clearcut forests, the pulp mills are establishing acacia plantations. Asia Pulp and Paper's Indah Kiat pulp and paper mill in Riau province has a production capacity of 1.8 million tons of pulp and 654,000 tons of paper. Unresolved land rights conflicts exist on more than 50,000 hectares of APP's concessions.[39] In an attempt to address its serious problems with maintaining fibre supply in the future, Indah Kiat is reported to be working in collaboration with the University of Beijing on GM tree research.[40]

Fast growing tree plantations produce wood that is suitable for the pulp and paper industry, for charcoal or for pit props. Producing more fibre for the pulp industry will not change the demand for high quality decorative tropical hardwoods for the construction industry, which come largely from native forests.

Demand for timber is not the only cause of deforestation. Forests are opened up by roads, submerged by hydropower dams, or cut down for cash crops (such as soya) or cattle ranching. Mining and oil extraction in forests is massively damaging both for the forests and the people that live there. Creating new industrial tree plantations has no affect whatsoever on this destruction.

Any large corporation must continually expand in order to repay debt and investment costs and to keep shareholders content. Aracruz Cellulose is the world's largest producer of bleached eucalyptus pulp, with 31 per cent of world market share.[41] The eucalyptus trees which feed Aracruz Cellulose's pulp mills in Brazil have been bred for fast growth for three decades. Aracruz's monoculture plantations consist of some of the fastest growing trees in the world. But Aracruz continues to expand both its pulp production and its area of plantations, putting more pressure on local people's livelihoods and what little remains of the Mata Atlantica forest in the area. Aracruz is also carrying out research into GM trees.[42]

Trees genetically modified for fast growth are likely to consume even more water than the trees currently used in industrial tree plantations,[43] which will lead to more dried up rivers and streams, more lowering of water tables and more dried up wells. Nutrients will be removed from the soil more quickly, requiring more chemical fertilizers. GM trees will grow faster than native trees and could be highly invasive of surrounding forests, crowding out vegetation and destroying habitat for the animals, birds, insects and fungi that have evolved to live in native forests.

Proponents of industrial plantations and GM trees assume that ever-increasing demand for timber products is an unalterable fact. They ignore the fact that most of the pulp produced in the South is to feed demand in the North. Aracruz, for example, exports 95 per cent of its pulp. Per capita paper consumption in Germany is 70 per cent of that in the US. On average, people in Vietnam consume two per cent of the amount of paper consumed by people in the US.[44] Literacy rates in the US, Germany and Vietnam are almost identical.

Almost 40 per cent of paper is used for packaging. Sixty per cent of the space in US newspapers is taken up by adverts.[45] In 2002, Jukka Härmälä, Stora Enso's chief executive officer, explained in a presentation titled "Achieving our Growth Ambitions" that the key factor in increased paper demand was increased spending on advertisements in newspapers and magazines.[46] Ever increasing paper consumption is neither necessary nor inevitable.

2. GM trees cannot help reverse climate change

In December 2003, the ninth Conference of the Parties (COP-9) to the UN Framework Convention on Climate Change reached a decision allowing Northern companies and governments to establish plantations in the South under the Kyoto Protocol's "Clean Development Mechanism" (CDM). These carbon sinks are intended to absorb carbon dioxide and to store carbon. COP-9 allowed the use of plantations of GM trees as carbon sinks.[47]

The idea that planting trees can help reverse climate change is based on the false assumption that one ton of carbon released by burning coal or oil is the same as one ton of carbon contained in a tree.

Carbon stored in the form of fossil fuel under the earth is stable and unless corporations dig it out and burn it, it will not enter the atmosphere. Tree plantations, in order to remain as a carbon store, have to be protected from catching fire, from being destroyed by pests, diseases or being logged. Trees have to be prevented from dying and rotting. Local communities have to be persuaded not to try to reclaim the land they lost to the plantations by cutting down the trees.

In terms of the impact on the climate, these are two different types of carbon which cannot be added to, or subtracted from, each other.

Including GM trees in the CDM makes a bad situation worse. In 1993, Japanese car manufacturer Toyota started field trials to test trees which had been genetically modified to absorb more carbon. While carbon absorption increased, Toyota's scientists also noted a dramatic increase in water consumption.[48]

3. Genetically modifying trees for reduced lignin is no solution to pulp mill pollution

To produce bleached kraft pulp, trees are chipped, cooked under pressure, washed and then bleached. Toxic chemicals are used in the cooking process to remove lignin, a glue-like substance that holds wood cells together and makes trees strong. As lignin causes yellowing of paper, any lignin remaining has to be bleached.[49]

Forestry scientists argue that by genetically modifying trees to have less lignin they have found a way of making pulp mills less polluting. "The costly portion of the pulp and paper making process, from both an economic and environmental perspective, is attributable to the removal of lignins. Therefore, it is highly desirable to develop means by which lignin content is decreased, or make lignins more extractable," explained forestry scientists from Oxford University and Oregon State University in a paper published in *Plant Biotechnology Journal* in 2003.

The risks associated with reduced-lignin GM trees include trees which are weakened structurally and which are more vulnerable to storms. Reduced-lignin trees are more susceptible to viral infections. Reducing lignin can reduce trees' defences to pest attack, leading to increased pesticide use. Low-lignin trees will rot more readily, with serious impacts on soil structure and ecology.[50]

If reduced-lignin GM trees were to cross with forest trees these impacts would not be limited to plantations. Although reduced lignin GM trees might be less competitive than native trees, the GM trees would be planted in vast numbers. If the plantation was near to a small population of native trees of the same species, the GM trees could overwhelm the reproduction of same-species native trees. Trees that cannot resist storms and which are at risk from attack by pests and viral infections could take over ecosystems and wipe out same-species native trees locally.[51] They could also lead to a rapid increase in insect populations.[52]

Focusing narrowly on lignin as the cause of pollution from pulp mills, GM proponents can argue that reducing the amount of lignin in trees is a reasonable solution. They overlook other possible solutions such as using crops like hemp which have lower levels of lignin than trees. Growing plantations of GM trees with reduced lignin fails to address any of the environmental and social problems that industrial plantations cause local communities. Rather than asking questions about the nature of the global pulp and paper industry for which they are working, forestry scientists are asking whether genetically modifying trees for reduced lignin will work.

4. Insect-resistant GM trees will not lead to decreased pesticide use

Monoculture tree plantations face a permanent threat of insect attack. When that happens, the only solution is very often to apply chemical pesticides. Biotechnology offers the possibility of GM trees that are insect resistant, usually achieved by introducing genes from the bacterium *Bacillus thuringiensis* (Bt). The resulting GM trees produce their own insecticide, which kills insects that try to feed from the tree. Scientists at Forest Research in New Zealand have genetically modified radiata pine in this way.[53] GM tree proponents claim that this development will lead to less need to spray plantations with pesticides.

However, pests are more likely to develop resistance to an insecticide that is always present. Genetically modified Bt cotton has been widely planted in China. While it has initially led to reduced pesticide use, there are signs that the cotton bollworm is developing resistance to Bt cotton. Liu Xiaofeng from Henan Agriculture Department's cotton office recently told Reuters that the bollworm would no longer be affected by genetically modified Bt cotton trees in six or seven years' time.[54]

If pests became resistant to GM insecticide producing trees, plantation managers' "solution" would be to spray yet more pesticides.

Until pests develop resistance, GM Bt trees may have an advantage over forest trees which are vulnerable to insect attack, thus increasing the risks of Bt trees invading surrounding forests. If they did so, GM Bt trees would disrupt insect population dynamics in natural forests as well as in plantations.

5. Herbicide-tolerant GM trees will not lead to decreased herbicide use

In 1995, Monsanto produced a herbicide-tolerant GM eucalyptus in Brazil. "We estimated that the modification would cut weed-control costs in half and would increase final yield by 10 per cent," David Duncan, Monsanto's former head of forestry, told journalist Casey Woods in 2002.[55] Scientists at Forest Research in New Zealand have produced herbicide resistant GM spruce and pine trees.[56] The trees are currently being tested in field trials.

Glyphosate is the active ingredient in Monsanto's Roundup herbicide. Monsanto boasts that its glyphosate products "are among the world's most widely used herbicides." Monsanto describes its glyphosate herbicides as "broad-spectrum, non-selective herbicides." In other words, glyphosate herbicides will kill just about anything green with which they come into contact.

As Viola Sampson of Eco-Nexus and Larry Lohmann of the Corner House point out "Trees genetically engineered to be tolerant of herbicides will further entrench the use of the chemicals in corporate and state attempts to create wooded landscapes free of 'extraneous' species".[57]

Plantations of GM herbicide-tolerant trees could result in increased use of herbicides, for two reasons. First, the fact that the trees cannot be damaged by the herbicide could encourage irresponsible use of herbicides by plantation managers. GM tree plantations could be sprayed at any stage in the growth of the tree.

Second, GM trees which are tolerant of Roundup are designed to be used in plantations where Roundup is used as the herbicide. Using a single herbicide to remove weeds increases the chances of the weeds developing resistance to that herbicide. As scientists from the University of Abertay Dundee in Scotland and the Max Plank Institut für Chemische Ökologie in Germany explain, "Resistance to herbicides, such as Round-Up or glyphosate, the most commonly quoted in anti-GM literature, can only become a significant problem if we rely on it as a sole source of killing weeds".[58] The scientists are advocating using a cocktail of chemicals to deal with weeds in plantations. In this case, GM trees which are designed to be tolerant of a single herbicide would be of little benefit.

Still more herbicides would be needed, if herbicide resistant GM trees were to cross with related trees outside the plantation, or if herbicide resistant GM trees were to spread outside plantations as weeds.

Herbicide tolerant weeds have started to appear in farmers' fields. In 2003, Bob Hartzler, Professor of Agronomy at Iowa State University, produced research indicating that in the past seven years five weed species had become tolerant of the herbicide glyphosate.[59]

In Argentina, 11 million hectares have been planted with genetically modified soya since 1996, covering half the country's arable land. The GM soya is resistant to Monsanto's Roundup herbicide. Between 1996 and 2001 Monsanto halved the price of Roundup in Argentina. Use of glyphosate in Argentina has exploded, up from 13.9 million litres in 1997, to 150 million litres in 2003. Farmers have to use more and more herbicides in an attempt to control weeds which have also become tolerant of Roundup. As a result, in Colonia Loma Senes in northern Argentina, livestock have died and small farmers have lost their crops as pesticide spray spread from neighbouring GM fields. Families report skin rashes and smarting eyes.

In response to criticism of GM soya use in the country, Argentina's council for biotechnology, Argenbio, argued that GM soya has allowed farmers to avoid using a cocktail of chemicals on their crops. Gabriela Levitus, the executive director of Argenbio, told the UK's Daily Telegraph that "damage had been caused by some farmers' reluctance to practice crop rotation, but that would be true of any monoculture, whether the crop was genetically modified or not". However, GM soya seeds which grow after being dropped during harvesting cannot be killed by applications of normal amounts of Roundup. Syngenta has run adverts in Argentina stating "Soya is a weed". Syngenta suggested that a mixture of paraquat and atrazine should wipe out the invasive GM soya.[60]

6. GM trees will not clean up pollution

Scott Merkle and Richard Meagher at the University of Georgia have produced GM cottonwood trees which can remove mercury from contaminated soil. The scientists modified Escherichia coli bacterium genes and inserted them into the cottonwood trees. The GM trees are designed to suck up the mercury from the soil and release it to the atmosphere.[61] In July 2003, the scientists planted a field trial of 60 GM cottonwood trees at the site of a 19th century hat-making factory in Danbury.[62]

Professor Joe Cummins, a geneticist at the University of Western Ontario in Canada, questions whether the GM trees will actually improve the situation. "The mercury 'remediation' will . . . simply move the pollution to the atmosphere, from which it will be redeposited over the cities of the Northeast and the lakes and waterways of northern USA and Canada", he wrote in *Science in Society* magazine. "Such 'remediation' is no remediation at all, it is just moving the problem from one place to another!" he concluded.[63]

David Salt, of Northern Arizona University, expressed his concerns about using trees to clean up pollution back in 1995. "Would we simply be exchanging soil pollution for air pollution?" he asked.[64]

7. Risks of genetic pollution

"Outcrossing", the term that scientists use for trees in plantations crossing with forest trees, is one of the biggest risks associated with field trials and commercial plantations of GM trees. In a paper published in 2003, Malcolm Campbell and colleagues at the Department of Plant Sciences at Oxford University acknowledged this risk: "Because most [plantation] trees have an abundance of wild or feral relatives, outcross, and display long-distance gene flow via pollen and sometimes seed, there is likely to be considerable activist and public concern about large-scale use of genetically engineered trees".[65]

Forestry scientists' solution to outcrossing is to produce GM trees which will not flower. The prospect of sterile monoculture plantations might look good from the corporate perspective, but if the trees were indeed sterile, this would mean thousands of hectares of trees without flowers, pollen, nuts or seeds. No birds or insects could live in such a plantation and the biodiversity of the plantation would be even lower than in today's monoculture tree plantations.

Much has been written about "terminator" technology in food crops, in particular the dangers it presents of allowing a small number of multinational corporations to control the world's food supply. Less discussed is whether the technology actually works. There is not a single published study that investigates whether sterile GM crops remain sterile under field conditions, according to Norman Ellstarnd, a professor of genetics at the University of California.[66]

Whether GM trees are in fact sterile, and would remain that way throughout their lifetimes is almost impossible to prove. Trees have very long lifespans and the only way of knowing that trees genetically engineered for sterility will remain sterile for their entire lifespan is by repeatedly conducting trials lasting the hundreds of years of a tree's lifespan.

Scientists admit that there are problems with attempts to engineer sterile trees. For example, Ron Sederof, a botanist at North Carolina State University, and Simcha Lev-Yadun, a plant geneticist at the University of Haifa in Israel, wrote in a letter to Nature Biotechnology:

> The most common strategies to suppress gene flow are based on suppression of genes essential for the development of reproductive structures, especially pollen and seeds. These approaches are limited in two ways.

> The first problem is that suppression of the activity of the target genes may not be complete; and second, the transgenes themselves may undergo gene silencing resulting in reversal of suppression.[67]

The term "gene silencing" refers to the fact that genes can be switched on or off at different times during a tree's life, as a result of stresses such as extremes of heat or cold, drought, storm, disease or pests. Ricarda Steinbrecher, co-director of Econexus, a UK-based NGO, points out that "No risk assessment can predict the interference that genetic engineering will have on the stress response and the aging of trees".[68]

As Steinbrecher explains, scientists long since stopped discussing whether it would be possible to prevent genes from GM plants from escaping into the wild. Instead they are arguing about what the impact of the genetic pollution might be, with many of them denying that there is a problem. For example, Kevan Gartland from the University of Abertay Dundee in Scotland and colleagues argue that "There is currently no clearly compelling evidence of significant damage due to limited amounts of GM tree pollen being able to spread within the environment".[69] The argument is disingenuous. Gartland and colleagues need to refer to research which proves that GM trees are safe, rather than point at a lack of evidence when few (if any) independent research tests have been carried out. Moreover, it is hardly in the interests of the pulp and paper industry (or the scientists whose work the industry supports) to carry out research which might indicate a serious danger with GM trees.

Scientists at Oregon State University have monitored gene flow from non-GM poplar plantations. They found gene flow from the plantation poplars took place more than 10 kilometres away from the plantation. The researchers consider that gene flow is inevitable if GM plants are grown close to their relatives.[70] Determining a "safe" distance from wild relatives is difficult, because of the huge distances that pollen can travel. Pine tree pollen has been found in India 600 kilometres from the nearest pine tree.[71]

Some trees can re-grow from broken twigs and others send suckers up from their roots. Seeds can float down rivers. Trees, whether genetically modified or not do not respect international boundaries. It is conceivable that GM trees (or genes from those trees) planted in one country could spread into neighbouring countries, regardless of international legislation on importing GMOs.

8. GM elm trees are no solution to Dutch elm disease

Scientists at the University of Abertay in Dundee, Scotland have produced GM elm trees which are resistant to Dutch elm disease. In the US, scientists at Cornell University are working on GM American chestnuts which are resistant to chestnut blight fungus.

The wild populations of both of these trees have in the past been devastated by fungal diseases. Research which promises to replace trees almost completely lost to the British and US landscapes is almost bound to be popular with the public.

Some GM tree proponents see this type of research as a possibility to improve the image of GM tree research with the public. For example, Don Doering, a senior researcher with the World Resources Institute, a Washington DC-based think tank, told Science magazine that genetically modifying the American chestnut to be resistant to blight fungus is an opportunity to "speak directly" to the public to demonstrate biotech's societal benefits.[72]

However, if GM elms are designed to resist the latest outbreak of the fungus, this is of little value if the fungus returns in a more destructive form. This has happened in the past. Dutch elm disease appeared in the northwest of Europe

around 1910.[73] Thirty years later the epidemic died down. In the 1960s it was back. Europe's elms had almost no resistance to the disease and millions of trees were killed.

Moreover, the dangers with this sort of research are similar to those for any other type of GM trees. The engineered genes might escape if the trees were to breed with wild relatives.[74] The results are unpredictable.

Another problem is that when forestry scientists breed trees, they produce vast numbers of trees but with very narrow genetic diversity. For example, Radiata Pine is one of the plantation industry's favoured trees. There are four million hectares planted with the tree worldwide, but only five radiata pine forests left anywhere in the world: three on the Californian coast and two on islands off the coast of Mexico. Scientists from Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO) are desperately collecting seeds from the few remaining wild radiata pine trees left. As CSIRO's Colin Matheson points out, "Australia's radiata plantations are much less diverse than the native populations although they occupy a much greater area".[75]

GM breeding programmes (even more so than non-GM breeding programmes) could lead to a similar squeezing of genetic diversity of elm and American chestnut trees. In the long run this would make the trees more vulnerable to disease rather than less.

9. Do GM trees make economic sense?

Apart from widespread public concern about GMOs in general, an important reason why GM trees have not yet been commercially planted except in China, is that GM trees simply do not make economic sense, at least for the time being.

In 1999, Roger Sedjo of the conservative think tank Resources for the Future wrote that "forestry is on the threshold of widespread introduction of genetic engineering".[76] Sedjo estimated that herbicide tolerant GM trees could save industry US$975 million a year worldwide. The source for the figure on which Sedjo based his calculations of potential savings is a report produced by a pro-biotech consulting company called Context Consulting (now called the Context Network)[77]. When I asked Sedjo for a copy of the report, he replied, "I don't think it was publically [*sic*] available. . . . I guess I would suggest that you contact the successor company to see if they will provide you with a full copy of the study." Context Network did not reply to my repeated requests for the report.

In 2003, Sedjo was still using the same source for his estimates of the potential economic benefits of GM tree plantations.[78] Sedjo now seems a little sheepish about his enthusiasm about the savings that herbicide tolerant trees could present the plantation industry. "In more recent work, papers not yet in print . . . I suggest reasons why that full potential is unlikely to be reached although I don't try to recalibrate the figure to provide an 'actual' estimate," he told me.[79]

In fact, several companies which were at one time involved in GM tree research have since pulled out. Weyerhaeuser has apparently withdrawn from GM tree research because of the long wait before the research will generate a profit. "When you have to wait 20 to 30 years to get payback," Todd Jones, director of Weyerhaeuser forest biotechnology, told Science magazine in 2002, "you have to have something that looks like it's going to have some real economic potential. If we look at economic models for some of the genes that do appear to be out there, there aren't that many that make that hurdle".[80] Regarding herbicide tolerance, Jones pointed out that applying herbicides "is not that large of an expense" in the forest industry.

Weyerhaeuser's publicity material includes the following statement: "Weyerhaeuser's genetically improved trees, both in the past and in the foreseeable future, are not altered by direct manipulation of DNA or the use of genetically modified organisms (GMOs)".[81] I wrote to Frank Mendizabel, Weyerhaeuser's director of media relations, to ask some questions about Weyerhaeuser's involvement in GM tree research, including whether the company had ever carried out any field trials of GM trees. Mendizabel declined to answer my questions, but repeated the statement from Weyerhaeuser's publicity material. Clearly Weyerhaeuser and Mendizabel have forgotten that in 1997 the company planted 400 hectares of herbicide tolerant GM eucalyptus trees in Washington State.[82]

Oil giant Shell has closed down its research programme into GM trees, also for economic reasons. In 1998, Shell produced GM eucalyptus trees and carried out trials in Britain, Uruguay and Chile. Shell's researchers planted 600 square metre field trials in Uruguay and Chile. Trials in Britain were in greenhouses. By the end of 1999, Shell had pulled out of GM tree research. "It was a stage when there was an extremely bad reaction to the technology, and I think many companies were very wary at that point," Stuart Christie, Shell's forestry technology manager for South America told journalist Casey Woods in 2002.[83]

In December 2000, Shell Forestry confirmed that its decision to stop its GM tree research programme was because the research made no economic sense:

> Although Shell Forestry has, in the past, conducted carefully controlled GM trials under clear regulatory guidelines, we have concluded that significant further development is still required over a number of years to demonstrate that the technology is sound, environmentally acceptable and economically worthwhile. For our own forestry activities, this further work is not commercially justified and we have therefore stopped our research programme in to genetically modified trees.[84]

Shell later made a "business strategy decision" to sell off its involvement in forestry according to Jeroen van den Berg in Shell's Renewables department.[85] The company sold off its forestry companies between 2000 and 2004.

During the 1990s, Monsanto carried out GM tree research, but has since pulled out. In 1996, together with ForBio, an Australian tree biotech company, Monsanto set up a joint venture in Indonesia called Monfori Nusantara.[86] Monfori's US$6 million factory in Bogor had the capacity to produce 15 million plants a year.[87] Both Monsanto and ForBio were at the time conducting research into GM trees. In 1995, Monsanto produced a GM herbicide tolerant eucalyptus tree in Brazil.[88] ForBio's work included research into sterile trees and GM trees engineered for herbicide tolerance and insect resistance.[89] Several reports appeared which stated that Monfori was planting GM trees.[90] In June 2004, Monfori's Suzi Madjid told me that "Monfori never produced GM trees".[91] Monfori now produces "high quality 'elite' microplants of Teak, Acacia and hybrid Eucalyptus for Indonesian plantation forestry" as well as ornamental flowers, according to the company web-site.[92] During 1999, ForBio went bankrupt and Monsanto sold its shares in Monfori.[93] In April 1999, Monsanto was one of the founding members of a GM tree research joint venture called ArborGen. Monsanto pulled out six months later. By the end of the year, Monsanto had dropped all its involvement in forestry.

Stora Enso, the world's second largest pulp and paper company, stated in 1999 that the company had "decided to refrain from any commercial use of controversial genetic engineering techniques on trees or any other organisms".[94]

> [G]enetic engineering involves profound ethical questions. The fundamental issue is that genetic engineering modifies the very 'code of life' through an artificial, asexual process. We must ask ourselves whether we have

> the right to do such things to ourselves or to any other living things. From a moral point of view it is equally important to weigh the likely benefits of this technology against the potential risks – and to assess which groups stand to gain or lose out.[95]

Nevertheless, Stora Enso continued to carry out research into GM trees, "to keep up to date with developments". Stora Enso Celbi, which is 100 per cent owned by Stora Enso has been involved in GM tree research through its involvement in a European Union-funded research project called IntelFibre.

Oregon State University's Steven Strauss told me that there is no "pressing need for the technology [of GM trees] at present in the USA". He explained that this is "due to a lack of tax incentives for intensive tree-based pulp and bioenergy plantations, low world pulp prices, etc." However, he added, "This of course could change radically overnight if the world were to get serious about carbon emissions control and sequestration".[96]

The decision reached in December 2003 at the ninth Conference of the Parties to the UN Framework Convention on Climate Change allowing Northern companies and governments to establish plantations of GM trees in the South under the "Clean Development Mechanism" might be precisely the subsidy that the GM tree proponents have been looking for to make GM trees appear economically attractive.

Several companies with very deep pockets are involved in ongoing research into GM trees, including International Paper, Meadwestvaco, Potlatch Corporation, Aracruz, Suzano, Nippon Paper and Oji Paper.

10. Do scientists know what they are doing? And should we trust them?

Genetic modification of plants is something completely new. It allows scientists to produce plants containing genes that could not possibly occur in nature. As with anything new, the potential risks and dangers cannot be known beforehand. Recent history is littered with products and discoveries which scientists assured us were safe, and whose use was widespread, before the dangers of these products became widely known: nuclear power, x-rays, chlorofluorocarbons (CFCs), dioxin, asbestos, dichlorodiphenyltrichloroethane (DDT), thalidomide, polychlorinated biphenyls (PCBs), polyvinyl chloride (PVC), to name a few.

This is not an attempt to argue that science is wrong or that everything new is automatically bad. However, when scientists announce that a new discovery or process is "safe" we would be wise to ask questions about the validity of the claim, particularly when the scientists are funded by the industry that stands to benefit from the new discovery.

James Hancock is the director of the Plant Breeding and Genetics Programme at Michigan State University. In a 2003 paper, published in BioScience, he argued that GM trees will inevitable cross with wild relatives. "The factors limiting gene flow between compatible relatives can be largely ignored, as transgenes will eventually escape into the natural environment if there is a compatible relative near the transgenic crop, unless the transgenic crop produces no viable gametes or has a system incorporated that prevents embryo viability," he wrote.[97]

Steven Strauss at Oregon State University commented on Hancock's article in the same issue of BioScience: "We can also predict with high confidence that the genetic confinement systems Hancock refers to will not provide absolute containment." Strauss continued by discussing how much gene flow might be acceptable and concludes that "the difficulty is in deciding how little is little enough. Unfortunately, for some novel genes, estimating 'negligibility' is anything but a little task".[98]

Neither Hancock nor Strauss argues for a ban on releases of GMOs. Instead they argue for the reverse: a weakening of regulation of GMOs. They argue that GM trees are no different to any other trees and as genes will in any case escape, regulators should focus on whether plants crossed with the GMOs might spread as weeds or whether the novel genes might harm the plants with which they cross.

Yet there is considerable uncertainty within the ranks of GM tree proponents as to how the dangers of GMOs should be assessed. In a pro-GM paper published last year in The Plant Journal a group of scientists pointed out that GMOs present "a relatively new area of research". They explained that when it comes to GM tree research, "what to measure and how to measure it are still being debated".[99]

In other words the scientists don't even know what problems to look for. If they do decide what to look for (which they are currently not sure how to do), they don't know how to measure the problems they will find.

Viola Sampson and Larry Lohmann point out that

> [M]uch of the data which adequate risk assessment of GM trees demands is unobtainable. For instance, in practice it is not possible to measure accurately to what extent GM plants or their genes might spread, simply because of the sheer size of the area which would need to be thoroughly examined for migrants. Second, serious risk assessment would exclude GM trees from precisely those uses for which they are being principally developed. For example, Professor Kenneth Raffa at the University of Wisconsin suggests that risks related to the evolution of insect resistance can be limited if large or homogenous plantations are avoided – a recommendation inherently at odds with the industry's requirements.[100]

Nevertheless, Strauss is in favour of going ahead with commercial plantations of GM trees as a way of learning by doing. "As with other forms of novel breeding, the extent of testing needed will be determined empirically – via adaptive management – during early commercial applications," Strauss wrote in 2002.[101] "Commercial applications" would involve planting millions of GM trees. Once GM trees from these plantations have crossed with forest trees, and the impacts are all too visible, it will be too late to recall the genes to the laboratory. Perhaps this is precisely what Strauss and his colleagues want.

3. A web of actors: Some of the research institutions and companies involved »

Footnotes

[37] Steven Strauss, Malcolm Campbell, Simon Pryor, Peter Coventry and Jeff Burley, Plantation Certification and Genetic Engineering: FSC's Ban on Research is Counterproductive, *Journal of Forestry*, December 2001.

[38] The argument that GM trees will take pressure off native forests is a variation of the argument put forward by proponents of industrial tree plantations, that plantations will relieve pressure on forests. For a response to this argument and other arguments frequently brought out to justify ever increasing areas of industrial tree plantations,

see Ricardo Carrere, Ten Replies to Ten Lies, Briefing Paper Plantations Campaign, World Rainforest Movement, August 1999.

[39] Jens Wieting, Clearcut Paper: Asia Pulp & Paper, Asia Pacific Resources International Holdings Ltd and the End of the Rainforest in Sumatra's Riau Province, Robin Wood, Hamburg, July 2004.

[40] P. J. Dart, I. H. Slamet-Loedin and E. Sukara, Indonesia, in G.J. Persley and L.R. MacIntyre (eds) Agricultural Biotechnology: Country Case Studies, CAB International, 2002, page 85.

[41] Aracruz Profile, Aracruz Cellulose. For more information about the problems caused by Aracruz's operations, see, for example, the following two reports:

Ricardo Carrere, The environmental and social effects of corporate environmentalism in the Brazilian market pulp industry, Paper prepared for the workshop on Business Responsibility for Environmental Protection in Developing Countries organised by the United Nations Research Institute for Social Development (UNRISD) and the Universidad Nacional (UNA), in Costa Rica in September 1997.

Where the trees are a desert – a photo essay, Carbon Trade Watch Info Tour Exhibition, 2004.

[42] Aracruz's Forest Improvement Manager, Gabriel Dehon Rezende, confirmed in an e-mail dated 23 July 2004 that Aracruz is carrying out laboratory research into GM trees.

[43] Viola Sampson and Larry Lohmann, Genetic Dialectic: The Biological Politics of Genetically Modified Trees, The Corner House, Briefing 21, December 2000.

[44] The comparison of paper consumption in different countries is based on figures for 2002 available on World Resources Institute's web-site: Resource Consumption: Paper and paperboard consumption per capita.

[45] Ricardo Carrere, Ten Replies to Ten Lies, Briefing Paper Plantations Campaign, World Rainforest Movement, August 1999.

[46] Härmälä's powerpoint presentation featured a diagram which compared "weak economy" with a "healthy economy". In a healthy economy, "increased ad spending" led to "increased paper demand" and "appropriate pricing". Jukka Härmälä *Achieving our Growth Ambitions*, Capital Markets Day 2002, Stora Enso.

[47] For more information on plantations and climate change, see the following:

Larry Lohmann, The Dyson Effect: Carbon #Offset' Forestry and the Privatization of the Atmosphere, Corner House Briefing 15, July 1999.

Larry Lohmann, Democracy or Carbocracy? Intellectual Corruption and the Future of the Climate Debate Corner House Briefing 24 October 2001.

World Rainforest Movement's web-site has a section dedicated to carbon sink plantations.

See also Sinkswatch and Carbon Trade Watch.

The Corner House has produced several reports on climate.

More of my articles about carbon sinks and GM trees are available here.

[48] Rachel Asante Owusu, GM technology in the forest sector: A scoping study for WWF, Worldwide Fund for Nature UK, November 1999.

[49] This section is largely based on an article I wrote for the World Rainforest Movement Bulletin June 2004: Genetically engineered trees: The pulp industry's dangerous 'solution'.

[50] Viola Sampson and Larry Lohmann, Genetic Dialectic: The Biological Politics of Genetically Modified Trees, The Corner House, Briefing 21, December 2000.

In a 2001 paper published by the Oxford Forestry Institute, Peter Coventry argued that Forestry Stewardship Council should allow the certification of GM tree plantations as "well managed". Regarding the impact of GM trees with reduced lignin on soils, he wrote: "the wood chemistry of exotic species is thought to effect [sic] the ecology of plantations far more than lignin modification of a native species". Coventry argued that since exotic tree plantations are damaging to soil, and FSC has certified several such plantations, then FSC should not exclude GM trees from certification. Coventry's argument about the impact of exotic tree species on soils could also be used as a reason for FSC to exclude exotic tree plantations from its certification system.
Peter Coventry, Forest Certification and Genetically Engineered Trees: Will the two ever be compatible? Oxford Forestry Institute Occasional Papers, No. 53, 2001.

[51] Toby Bradshaw and Steven Strauss acknowledged this point in their paper, Breeding strategies for the 21st Century: domestication of poplar, published in D.I. Dickmann, J.G. Isebrands, J.H. Eckenwalder and J. Richardson (eds) *Poplar Culture in North America*, National Research Council of Canada, 2002.

[52] Viola Sampson and Larry Lohmann, Genetic Dialectic: The Biological Politics of Genetically Modified Trees, The Corner House, Briefing 21, December 2000.

[53] Reduce Chemical Spraying, Forest Research, New Zealand.

[54] Nao Nakanishi, China official says GMO cotton developing super pest, *Reuters*, 28 May 2004.

[55] Quoted in Casey Woods, Here come the super trees, Latin Trade, May 2002.

Monsanto has since pulled out of forestry research.

[56] Submissions called on GM pine tree applications, Environmental Risk Management Authority New Zealand Press Release, 19 July 2000.

[57] Viola Sampson and Larry Lohmann, Genetic Dialectic: The Biological Politics of Genetically Modified Trees, The Corner House, Briefing 21, December 2000.

[58] Kevan Gartland, Robert Crow, Trevor Fenning, and Jill Gartland, Genetically modified trees: Production, properties, and potential, *Journal of Arboriculture*, Vol. 29, No. 5, September 2003.

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Paul Brown GM soya 'miracle' turns sour in Argentina, *The Guardian*, UK, 16 April 2004.

Tim Utton, Nightmare of the GM weeds, *Daily Mail*, UK, 15 April 2004.

Seamus Mirodan and David Harrison, GM soya saved us, says angry Argentina after 'superweed' claim, *Telegraph*, UK, 18 April 2004.

[61] Naomi Lubick, Designing Trees, *Scientific American*, 2 April 2002.

[62] Phil Williams and Richard Meagher, UGA researchers involved in first trial using transgenic trees to help clean up toxic waste site, University of Georgia in Athens press release, 11 September 2003.

[63] Joe Cummins, Transgenic Trees Spread Mercury Poisoning, *Science in Society*, No. 20, Autumn/Winter 2003.

[64] D.E. Salt et al, Phytoremediation: A novel strategy for the removal of toxic metals from the environment using plants, *Bio/Technology*, No. 13, 1995, pages 468-474, quoted in Michael Cuba and Anne Petermann, Genetically Engineered Trees: Myths and Realities, in From Native Forests to Franken-Trees: The Global Threat of Genetically Engineered Trees, produced by Action for Social and Ecological Justice, USA.

[65] Malcolm Campbell, Amy Brunner, Helen Jones and Steven Strauss, Forestry's fertile crescent: the application of biotechnology to forest trees, *Plant Biotechnology Journal* No. 1, 2003, pp. 141-154.

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[68] Ricarda Steinbrecher, The Ecological Consequences of Genetic Engineering, in Brain Tokar (ed.) *Redesigning Life? The Worldwide Challenge to Genetic Engineering*, Zed Books 2001.

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