GM Forest Trees – The Ultimate Threat

Genetically modified (GM) forest trees do not attract the same immediate health concerns as GM food crops. But in reality, they pose an even greater threat because they impact directly on natural forests that are essential for the survival of our planet. Dr. Mae-Wan Ho and Prof. Joe Cummins

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World status of GM forest trees

Most genetic modification of forest trees have been done by *Agrobacterium*-mediated DNA transfer; but bombardment with DNA-coated particles, or 'biolistic transformation' , has also been used. Of the 205 permit applications listed at the end of 2003, 73.5% originated in the USA, 23% in other OECD member nations (in particular, Belgium, Canada, France, Finland, New Zealand, Norway, Portugal, Spain and Sweden) and 3.5% elsewhere (Brazil, China, Chile, South Africa and Uruguay). Four traits account for 80% of the permit applications: herbicide tolerance (32%), marker genes (27%), insect resistance (12%), and lignin modification (9%). Of the tree species involved, *Populus*, *Pinus*, *Liquidambar* (Sweet Gum Tree) and *Eucalyptus* account for 85% of applications.

Although commercial interest was low during the first ten years of GM trees development, it has steadily increased since the late 1990s. By the end of 2003, 45% of the permits submitted were from industry, mostly for transgenic poplars. But to-date there has not been a concerted push for commercialisation of GM trees except in China, where more than one million GM trees have been planted in "reforestation" initiatives since commercialisation was approved by The Chinese State Forestry Administration in 2002 (see "GM trees get lost", this series).

Several companies, including Weyerhaeuser, Shell and Monsanto, at one time involved in GM tree research have since pulled out because it was not economically attractive. However, the decision reached in December 2003 at the ninth Conference of the Parties to the UN Framework Convention on Climate Change to allow Northern companies and governments to establish plantations of GM trees in the South under the "Clean Development Mechanism" might be the subsidy that GM proponents need to make GM trees seem economically attractive.

The overriding importance of forests

Forest trees are long-lived. Their root system is extensive, interacting with countless species in the soil biota that are crucial for recycling, storing and keeping nutrients within the forest ecosystem.
Above ground, forest trees provide shelter, home and food for indigenous peoples and between 1.5 to 2 million species of insects, birds, mammals, other plants, epiphytes, fungi and bacteria.
All human beings are dependent on forests in one way or another, for clean water, habitat, food, medicinal plants, and as recreational and spiritual sanctuaries.

Most of all, forests, especially the tropical rainforests, are essential for the water cycle that brings rain to crops; and for regulating the temperature of the earth, preventing places from getting too hot or too cold. Forests absorb carbon dioxide and produce oxygen; in that respect they are the 'lungs' of the living earth (see "Why Gaia needs rainforests" , *SiS* 20).

Losing forests to GM tree plantations would spell ecological disaster for our planet, especially as global warming is fast accelerating.

GM trees anathema to forest ecosystems

GM trees are designed for large monoculture plantations anathema to the bio-diverse natural forest ecosystems. Local people's names for industrial tree plantations are revealing. Eucalyptus is the "selfish tree", because eucalyptus plantations remove nutrients from the soil and consume so much water that farmers cannot grow rice in neighbouring fields. Mapuche Indigenous People in Chile refer to pine plantations as "planted soldiers", because they are green, in rows and advancing. In Brazil, tree plantations are "green deserts", and in South Africa, "green cancer". Throughout the Global South, organisations and networks are actively opposing industrial tree plantations on their land. GM trees will intensity both the problems of industrial plantations and the opposition from indigenous peoples.

A joint report by the World Rainforest Movement (WRM) and Friends of the Earth International (FoEI) says that the scientists claiming to "improve" trees by genetic modification are in reality working to "improve the profitability of the businesses" funding their research (http://www.wrm. org.uy/subjects/GMTrees/text. pdf). It continues:

> "But from a biological perspective there is no improvement whatsoever. Is a tree with less lignin better or worse than a normal one? It is clearly worse, given the resulting loss of structural strength which makes it susceptible to extensive damage during wind storms. Is a herbicide-resistance tree an "improvement" ? It is not, for it allows extensive herbicide spraying that affects the soil on which it stands, at the same time as it destroys local flora and impacts on wildlife. Is a flowerless, fruitless and seedless tree of any use to living beings? It does not provide food to myriad species of insects, birds and [other] species that depend on these as food. Is a tree with insecticide properties an improvement? It is a dangerous hazard to many insects species, which are themselves part of larger food chains."

GM trees violate international conventions

The WRM report points out that GMOs in general and GM trees in particular, are a clear violation of the Convention on Biological Diversity, which obliges governments to take a precautionary approach towards GMOs that may cause serious damage to biodiversity. GM trees also violate the spirit of the United Nations Forum on Forests, which was set up to protect the world's forests.

Unfortunately, the inclusion of GM trees within the framework of the Kyoto Protocol's Clean Development Mechanism means that the Climate Change Convention not only supports the expansion of monoculture tree plantations, but GM tree plantations supposed to act as better "carbon sinks".

The WRM and FoEI International are calling on all governments, especially the Parties to the Framework Convention on Climate Change and its Kyoto Protocol, to ban the release of GM trees. The campaign to ban GM trees was launched in January 2004 by the Finnish People's Biosafety Association and the Union of Ecoforestry (see "No to GM Trees", *SiS* 23).

Transgene contamination inevitable and unavoidable

Forest trees are tall, long-lived and produce abundant pollen and seeds that can be carried far and wide. Forest trees also reproduce asexually, sending out clones that spread long distances from the mother plant, thus promoting further transgene contamination. Contamination of native trees by GM trees is hence inevitable and unavoidable.

Low lignin GM trees increase destruction of forests & livelihoods

Low lignin trees are more susceptible, not only to storm damage but also to attacks by insects, fungi and bacteria (see "Low lignin GM trees and forage crops", *SiS* 23).

The reduced-lignin trait spreading to native forest trees will make them susceptible to storm, attack by pests, and fungal and bacterial diseases. Insect pest populations will also increase as a result.
While low lignin GM tree plantations may benefit the paper industry, they will destroy local livelihoods, forcing people to move away, some of them to new forests where they clear more land for farming. Tree plantations often follow the destruction of native forests. In Sumatra, for example, vast areas of forests have been cleared to feed pulp and paper mills; the clear-cut forests being replaced by acacia plantations.

The argument that planting faster growing GM trees is "growing more wood on less land" is misleading. 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. Also, the demand for timber is not the only cause of deforestation; road-building, dams, cash crops (such as soya in Brazil and Argentina) or cattle ranging, mining and oil extraction all contribute to destroying native forests, and creating GM tree plantations will do nothing to stem the destruction.
Fast growing GM trees will consume even more water than current industrial tree plantations, draining the already depleted aquifers and impacting on surrounding forests.

Most of the pulp produced in the South is exported to the North. Per capita paper consumption in Germany is 70% that in the US. Vietnam consumes on average 2% of the amount of paper consumed in the US, despite the fact that literacy rates in the US, Germany and Vietnam are almost identical. Nearly 40% of the paper is used for packaging, and 60% of the space in the US newspaper is taken up by adverts. According to Jukka Hamala, CEO of Stora Enso - the second biggest paper, packaging and forest products company in the world, whose sales totalled 12.4 billion in 2004 - the key factor in increased paper demand was increased spending on advertisements in newspapers and magazines. Thus, increasing paper consumption is neither necessary nor desirable.

Fast growing GM trees exacerbate climate change

The argument that planting GM trees can reverse climate change is also fallacious. Japanese car manufacturer Toyota started field trials of trees genetically modified to absorb more carbon in 1993. Unfortunately, while carbon absorption increased, it was accompanied by a dramatic increase in water consumption.

Tree plantations are much less effective in sequestering carbon than the native forest ecosystem. The biodiverse native forest ecosystem is an effective carbon sink. It has been estimated that the neo-tropical forests of Central and South America sequesters at least one tonne of carbon per hectare per year in biomass increase above ground. (It is possible that additional carbon is sequestered in the soil.) In contrast, destroying a hectare of forest releases 200 tonnes of carbon (see "Why Gaia needs rainforests" , *SiS* 23).

Fast-growing reduced-lignin trees will also rot more readily, returning carbon dioxide more rapidly to the atmosphere, thereby exacerbating global warming instead of ameliorating it.

Researchers used a NASA thermal infrared multispectral scanner from the air to assess energy budgets of experimental forests in Oregon in 1989. They found that a clear-cut forest area had a surface temperature of 51.8C, hotter than a nearby quarry, which registered 50.7C. The Douglas fir plantation with mature trees registered 29.9C, compared to 29.4C over the natural Douglas fir forest regrowth; while the coolest temperature of 24.7C was found over the 400 year-old forest. The cooling

effect of the natural forest ecosystem is not only important for alleviating global warming; it is also a significant indicator of sustainability.

Insecticidal GM trees destroy biodiversity

There is no doubt that the insecticidal GM trees will kill many insects, both target pest species and non-target species; that is, until the pests develop resistance within six or seven years, according to the estimate of Liu Xiaofeng from Henan Agriculture Department, a scientist critical of the GM cotton planted in China (see "GM cotton fiascos around the world", *SiS*25). At that point, more insecticides will have to be used, especially as new kinds of pests will have appeared.

The far greater threat to biodiversity is the spread of the insecticidal traits to natural forests. Laboratory feeding experiments have shown that Bt toxins produced in GM crops can harm beneficial predators that feed on insect pests, even when the pests themselves are not affected by the toxins. One class of Bt toxins (Cry1A) was found to harm butterflies, lacewings and mice. Another class (Cry3A) acts against insects belonging to the Order Coleoptera (beetles, weevils and stylopids), which contains some 28 600 species. Bt toxins are known to leach out of the roots into the soil, with potentially huge impacts on the soil biota.

Reduction of insect populations will in turn impact on birds and mammals that feed on insects.

Herbicide-tolerant GM trees make green deserts

GM trees have been made tolerant to broad-spectrum herbicides that kill all other plants. If that is not bad enough, they are also harmful to all species of animal wildlife including human beings (reviewed in *The Case for a GM-Free Sustainable World, ISP Report*). Plantations of herbicide-tolerant GM trees are really green deserts, and collateral damage to nearby forests and crops from spraying herbicides is inevitable, as is the pollution of drinking water.

Glyphosate is the most frequent cause of complaints and poisoning in the UK. Disturbances of many body functions have been reported after exposure at normal use levels. It nearly doubled the risk of late spontaneous abortion, and children born to users had elevated neurobehavioral defects. Roundup (Monsanto's formulation of glyphosate) caused cell division dysfunction that may be linked to human cancer. Glyphosate caused retarded development of the foetal skeleton in laboratory rats. It inhibits the synthesis of steroids and is genotoxic in mammals, fish and frogs. It is lethal and highly toxic to earthworms.

Glufosinate ammonium is linked to neurological, respiratory, gastrointestinal and haematological toxicities and birth defects in humans. It is toxic to butterflies and a number of beneficial insects, also to the larvae of clams and oysters, Daphnia, some fresh water fish such as the rainbow trout. It inhibits beneficial soil bacteria and fungi, especially those that fix nitrogen.

Health hazards

The health hazards of GM trees are common to those of other GM crops, but they will be exaggerated. Two of these in particular are worth mentioning.

Agrobacterium, used in the vector system for creating many GM trees, is a soil bacterium that causes tumours to grow on infected plants and is now known to be capable of transferring genes into animal and human cells (See "Common plant vector injects genes into human cells" http://www.i- sis.org.uk/ Agrobacterium. php). Scientists have warned that the *Agrobacterium* is extremely difficult to eradicate from the transgenic plants created, and can therefore serve as a potential vehicle for unintended

horizontal gene transfer to soil bacteria and all other species, including human beings, that come into contact with the transgenic crops. This danger is greatly increased in GM trees, especially on account of its extensive root system. The rhizosphere – plant root system - is a known hotspot for horizontal gene transfer.

The potential of *Agrobacterium* to mediate horizontal gene transfer, and the resulting hazards of spreading antibiotic resistance marker gene to pathogens; creating new bacteria and viruses that cause diseases; and causing cancer in animals including humans were reviewed in Chapter 11 of ISP report (www.indsp.org).

Another source of health hazard is the Bt toxins and other transgenes, which could be spread far and wide in the pollen of GM trees. All Bt toxins used as transgenes as well as the transgenes conferring glyphosate tolerance were found to have similarities to known allergens, and are hence suspected allergens (see "Are transgenic proteins allergenic?" ISIS report 05/01/ 2005 http://www.i- sis.org.uk/ATPA.php).

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