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COMPILATION OF VIEWS ON THE POTENTIAL ENVIRONMENTAL, CULTURAL AND SOCIO-ECONOMIC IMPACTS OF GENETICALLY MODIFIED TREES

Addendum

The Executive Secretary is circulating herewith, for the information of participants of the thirteenth session of the Subsidiary Body on Scientific, Technical and Technological Advice, an additional view received in response to notification 2006-027 of 4 May 2006.

* UNEP/CBD/SBSTTA/13/1.

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SUBMISSIONS FROM ORGANIZATIONS

GLOBAL JUSTICE ECOLOGY PROJECT

[SUBMISSION:ENGLISH]

Dear CBD Secretariat,

In preparation for the upcoming SBSTTA-13, I am sending you some information pertaining to the question of environmental, social and cultural impacts of genetically engineered [modified] trees.

Our overall analysis of the research done to assess these risks is that it is utterly inadequate. Projections can be made as to some of these risks based on the destructive impacts of other genetically engineered plants, however, the vast majority of these have been annual plants with no wild relatives, where GE trees are perennials with vast numbers of wild relatives. The lack of research on the specific risks of GE trees means moving forward with the commercialization of this technology is irresponsible. Irreversible contamination of native forests by GE trees is impossible to prevent. Even researchers themselves share this concern. In the FAO's Review of Forest Biotechnology Including Genetic Modification, when GE tree researchers were questioned about their top concerns about the technology, their second greatest concern was contamination of non-target ecosystems. Their greatest fear was public opinion.

Industry's assertion that intensively managed trees will take pressure off of native forests has no basis in reality. Increasing demand for forest products is already driving deforestation to clear land for plantation expansion. The primary reason that tree genetic engineering is being pursued is increased corporate profit. Given the potential for ecological and social disaster that could result from the commercial release of GE trees, enhancing the bottom line of a select group of corporations is certainly not worth the risk.

The discussion about GE Trees at the CBD is especially important today given the rising emphasis on the commercialization of genetically engineered trees for pulp and paper as well as cellulosic ethanol.

With concerns mounting about the competition between food and fuel due to crop-based agrofuels, the cellulosic ethanol industry is heavily promoting fuel produced from woody sources as the solution to this conflict, with fast-growing, easily digested genetically engineered trees a major focus of the research.

The claim that these so-called 'second generation' cellulosic feedstocks will eliminate food-fuel competition, however, is false. In many countries of the world, industrial timber plantations already compete with agricultural land. The rising economic incentive to grow tree monocultures resulting from the enormous increase in demand for wood generated by cellulosic ethanol will only worsen the conflicts between communities who need land for food, and companies who want the land to grow trees.

Additionally, the development of even more profitable, faster-growing genetically engineered trees will increase this conflict over land and create new incentives to destroy natural forests to make room for more profitable GE tree plantations. This direct destruction of forests, combined with the inevitable and irreversible contamination of native forests will have disastrous consequences for forest biological diversity and rural and indigenous communities.

Both the contamination of forests by GE trees and the outright destruction of forests for GE tree plantations will also exacerbate global warming by destroying critically important carbon sinks and through the direct release of carbon through the deforestation process. Global warming is the greatest threat to biodiversity on the Earth today. Commercial release of genetically engineered trees is a giant step in the wrong direction. A ban on the commercial release of GE trees is absolutely critical. The dangers are too great to do otherwise.

Sincerely,

Anne E. Petermann
Co-Director

Background Information on The Environmental and Social Impacts of GM Trees

Contamination of Native Forests

Among those trees receiving the greatest attention from industry scientists is the *Populus* family. Valued for their fast growth and easily manipulated genome, genetically engineered low-lignin poplars are an obvious choice for the development of cellulosic ethanol and paper pulp. However, *Populus* are also some of the more dangerous trees being engineered, with regard to contamination. Richard Meilan, a faculty member at Purdue University points out that *"The genus* Populus *includes about 30 species that grow across a wide climatic range from the subtropics in Florida to subalpine areas in Alaska, northern Canada and Europe."*1/ This raises a serious red flag concerning the potential genetic contamination that could be caused by the commercial release of a GE tree with such a large and widespread population of wild relatives.

Our understanding of the contamination potential from future plantings of GE trees is largely based on known contamination incidents from GE food crops and experimental plantings of engineered grasses. Since 2005, Greenpeace, in collaboration with GeneWatch in the UK, has maintained an online database of GMO contamination incidents, known as the GM Contamination Register.2/ Their 2006 report lists 142 publicly documented incidents, in 43 countries, since the introduction of commercial GE crops in 1996.

These incidents of contamination demonstrate that gene escape and GE contamination cannot be prevented once GE trees are released. GE trees would over time lead to a persistent contamination of the world's native forests, with disruptive ecological consequences.

An additional problem with GE tree plantations is that (unlike most crops) they are likely to be grown in the vicinity of genetically similar native and uncultivated tree populations. In these instances, well-documented cases of GE contamination of wild relatives are of particular relevance.

Highly relevant to our understanding of the potential threat from GE trees is a carefully studied instance of native grass contamination in the US state of Oregon, from a test plot of creeping bentgrass genetically engineered for glyphosate resistance. In 2004, researchers from the US Environmental Protection Agency found numerous grasses within 2 km of the experimental plot—as well as two samples 14 and 21 km away—that were contaminated by the GE grass.

Through further DNA analysis, they determined that the contamination had been caused by a combination of pollen and GE seed dispersal. As tree pollens can potentially travel two orders of magnitude farther than grass pollen, these experiments suggest that preventing contamination of native forests with pollen from native tree species that have been genetically engineered is virtually impossible. The impacts of this contamination, however, would depend to a large extent on the traits involved.

Nevertheless, irrespective of the specific traits, the genetic manipulation itself gives rise to risks. Several researchers have reviewed the ecologically disruptive character of genetic modifications, in terms of gene expression, ecological fitness and the production of potentially dangerous new metabolites. David Schubert of the Salk Institute also writes that, "unintended consequences arising from the random and

1/ ibid.

2/ http://www.gmcontaminationregister.org/

extensive mutagenesis caused by GE techniques opens far wider possibilities of producing novel, toxic or mutagenic compounds in all sorts of crops."3/

In a detailed analysis of over 200 published studies, researchers at EcoNexus in the UK documented significant increases in genetic instability, higher mutation rates, large-scale deletions and translocations of DNA, and other disturbing effects at the site of artificial gene insertion.4/ These disruptions in gene expression are also likely to have unpredictable impacts on native species that become contaminated via cross-pollination with GE varieties.

Low-Lignin Trees

The threat of GE trees contaminating native forests is especially serious in the case of trees manipulated for decreased lignin production, a trait being promoted to facilitate the production of cellulosic ethanol or paper pulp. Lignin is an important structural polymer that is also significantly responsible for trees' high levels of insect and disease resistance. The very fact that it is difficult to break down lignin has been shown to be essential to the resiliency of native tree species in the wild. Thus the consequences of a reduced lignin trait spreading from agrofuel plantations to native forests could be severe and irreversible.

Low lignin trees also have implications for the climate, according to the UK-based Institute for Science in Society, "*Aspen (*Populus tremuloides*) modified for reduced stem lignin … had reduced root carbon and greatly reduced soil carbon accumulation compared to unmodified aspen. The trees accumulated 30% less plant carbon and 70% less new soil carbon than unmodified trees.5/ This makes the transgenic tree highly undesirable in terms of reducing carbon in the atmosphere."6/*

Disease and Insect Resistance

Because lignin naturally protects trees from insects and disease, trees with modified lignin will probably have to be engineered with additional traits for disease and insect resistance, which leads to additional concerns, should these genes escape.

The UK research organization, The Corner House, notes, *"trees genetically modified for resistance to disease are likely to cause fresh epidemics"*7 by encouraging the survival of diseases resistant to the genetic modification. They also state, *"fungicide production engineered into GM trees to help them counter such afflictions as leaf rust and leaf spot diseases may dangerously alter soil ecology, decay processes and the ability for the GM trees to efficiently take up nutrients…"*. Fungicides engineered into trees are likely to exude from the roots, killing beneficial soil fungi and damaging soil ecology.

Another significant concern is that the evolution of new, more pathogenic viruses may be accelerated by GE tree viral resistance traits. Ricarda Steinbrecher elaborates, *"The potential of such newly recombined*

3/ David Schubert, *"Regulatory regimes for transgenic crops"*, *Nature Biotechnology* Vol. 23, pp. 785 – 787, July 2005.

4/ Allison Wilson, *et al.*, "*Genome Scrambling - Myth or Reality? Transformation-Induced Mutations in Transgenic Crop Plants"*, Brighton, UK: Econexus, October 2004, at http://www.econexus.info/pdf/ENx-Genome-Scrambling-Report.pdf. See also Jonathan R. Latham, et al., *"The Mutational Consequences of Plant Transformation"*, *Journal of Biomedicine and Biotechnology*, Vol. 2006, pp. 1-7, 2006.

5/ Hancock J.E., et. al., *"Plant growth, biomass partitioning and soil carbon formation in response to altered lignin biosynthesis in Populus tremuloides," New Phytol*., 2007, 173(4), 732-42.

6/ Cummins J. and Ho, Mae-Wan, *"Unregulated Release of GM Poplars and Hybrids"*, report submitted to the USDA APHIS in response to a permit application (06-250-01r) from Oregon State University for field tests of transgenic Populus Alba and Populus hybrids, August, 2007.

7/ Viola Sampson and Larry Lohmann, *Corner House Briefing 21: Genetically Modified Trees*, December, 2000, p. 8

*viruses to overcome the defenses of related wild plants, or even be able to infect new host plants, is a serious concern. In laboratory experiments infecting viruses have also swapped their protein coat for that of another virus that had been engineered into a plant...the new coat enabled a virus to travel between plants, carried by aphids."*8/

Insect resistance also conveys serious concerns. In China, more than one million GE poplars genetically engineered for the production of the *Bacillus thuringiensis* (Bt) toxin, an insecticide that targets the caterpillars of *Lepidoptera* (butterflies and moths) have been planted. The Nanjing Institute of Environmental Science in 2004 reported that the Bt poplars were already contaminating native poplars.9/

The escape of the Bt trait into native forests is problematic for numerous reasons. Insects have evolved with forest ecosystems for millions of years and the ecological implications of eradicating certain species of insects has not been assessed. The insects targeted by Bt trees are also an important food source for nesting songbirds, as well as other wildlife. Studies have found that Bt-toxin remains active and lethal after ingested and can make its way up the food chain and will actually bind to the intestines of non-target organisms, causing *"significant structural disturbances and intestinal growths".*10/ Deployment of Bt trees on a large scale could devastate pollinator populations.11 Additionally, Bt toxins leaching out of pollen and other plant tissues that wash into streams are lethal to caddisflies, the most diverse order of aquatic insects and an important food source for fish and amphibians.12

Beyond the impacts on forests and wildlife, however, are the impacts of Bt pollen on humans. Airborne Bt pollen may be toxic when inhaled.131415/ This could have serious ramifications for communities living in the proximity of GE tree plantations. This potential health impact has not been adequately studied.

In summary, the long-term consequences of the use of Bt trees or the escape of this trait into forests has not been adequately assessed.

Genetically modified poplars used in biofuel plantations may also be engineered to become sterile. Proponents of genetic engineering claim that adding a sterility trait to GE trees would help prevent contamination of non-engineered trees. Because of the complex nature of plant reproduction and gene regulation, however, and the genetic changes trees experience as they age, it is highly unlikely that any sterility in trees can be reliably sustained. This means that contamination by seed or pollen would continue to be a threat. It also means there is the potential for stands of native trees themselves to become

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8/ Ricarda Steinbrecher, *"The Ecological Consequences of Genetic Engineering"*, in Brian Tokar, ed.., Redesigning Life? The Worldwide Challenge to Genetic Engineering, London: Zed Books, 2001, p. 89-90.

9/ F. Pearce "Altered Trees Hide Out with the Poplars", *New Scientist*, 9/19/04, P.7

10/ C. Brown, S. Connor and M. McCarthy, "The End for GM Crops: Final British Trial Confirms Threat to Wildlife," 3/22/05, http://news.independent.co.uk/ low_res/story.jsp?story=622479&host=3&dir=58

11/ J. Losey et. al., "Transgenic pollen harms monarch larvae," Nature 399, 1999, p. 6733; and Hansen L. and Obrycki, J., "non-target effects of Bt-corn pollen on the Monarch butterfly (Lepidoptera: Danaidae), Abstract, North Central Branch meeting of the Entomological Society of America, March 1999; and Malone, L.A. et al., "In vivo responses of honey bee midgut proteases to two protease inhibitors from potato," *Journal of Insect Physiology* 44(2), 1998, pp. 141-147.

12/ E. J. Rosi-Marshall, et al., "Toxins in transgenic crop byproducts may affect headwater stream ecosystems," Proc. Nat. Acad. Sci. USA vol. 104 no. 41, October 9, 2007, pp. 16204 –16208.

13/ Kleter, G.A. and A.A.C.M Peijnenburg. 2002. Screening of transgenic proteins expressed in transgenic food crops for the presence of short amino acid sequences identical to potential, IgE-binding linear epitopes of allergens. *BMC Structural Biology*, 2: 8. At www.biomedcentral.com/1472-6807/2/8

14/ Vazque-Padron, R.I., et al. 2000. Cry1Ac protoxin from *Bacillus thuringiensis* sp. kurstaki HD73 binds to surface proteins in the mouse small intestine. *Biochemical and Biophysical Research Communications* 271, pp. 54-58

15/ Vazquez-Padron RI, et.al. 1999b. *Bacillus thuringiensis* Cry1Ac protoxin is a potent systemic and mucosal adjuvant. *Scandinavian J Immunology* 49: 578-584 partially sterile through cross-pollination, or become impaired in their development of flowers or seeds. Sterile trees would also be able to spread their transgenes through vegetative propagation.

Furthermore, the sterility modification itself has ramifications. Foremost are the likely impacts on native wildlife. Sterile trees do not provide food (seeds, pollen or nectar) for insects, animals or birds, which means that large monocultures of GE trees will displace a wide variety of native species. In addition, the trees themselves may be toxic.16/

Introduction of Non-Native Invasive Plants for Cellulosic Ethanol

GE tree escape, via seed or vegetative propagation, is possible even from non-native species without wild relatives. The case of bentgrass contamination is instructive here, as it describes contamination resulting from seed dispersal. GE eucalyptus is one tree being proposed by tree engineers as a potential feedstock for pulp mills or cellulosic ethanol plants. Eucalyptus, native only to Australia, is already a favorite species for pulpwood plantations worldwide. It is notoriously invasive and often out-competes native plant species. The invasive nature of eucalyptus has been extensively documented in South Africa and California.

The company ArborGen is currently engineering eucalyptus for cold tolerance so that it could survive at temperatures as low as -20ºc, which would greatly expand its potential range17 and create significant threats to forests in those climates. Extending the range of eucalyptus makes it possible for companies to replace slower-growing, less economically profitable (but carbon rich) native forests with fast-growing (but carbon poor) GE eucalyptus plantations in climates that were previously off-limits to these destructive actions. In his 2006 year-end report to stockholders, Rubicon CEO Luke Moriarty explains the economic potential: *"The excellent results of the best performers in the field trials would suggest that the level of cold tolerance can be extended even further, thus offering a broader geographic market for this new hardwood product than originally anticipated."*18

Besides direct clearing of native forests for eucalyptus plantations, the use of cold-adapted eucalyptus could result in the escape of these GE trees (via seed or asexual vegetative reproduction) into ecosystems and forests where they could out-compete native vegetation and displace wildlife.

ArborGen forsees millions of dollars in profits from sale of its GE low-lignin eucalyptus pulp, due to the fact that it is projected to be less expensive to process.19/ Eucalyptus is already a serious problem in Brazil, where plantations have replaced vast stretches of the *Mata Atlantica* coastal forest ecosystem. Increasing demand for eucalyptus for cellulosic ethanol, in addition to paper pulp, will most probably lead to the expansion of these eucalyptus plantations and the use of GE low-lignin eucalyptus, posing further threats to ecosystems like the *Mata Atlantica*.

GE Jatropha and Oil Palm

Beyond genetically engineering trees for cellulosic ethanol production, researchers are also exploring ways to engineer Jatropha and oil palm trees so that their oil-bearing seeds produce better biodiesel, as well as other oil-based products. India has identified eleven million hectares of land for future jatropha

16/ J. Cummins et. al.,

17/ Stephen Kasnet and Luke Moriarty, *"Rubicon Interim Report"*, Rubicon. 02/28/07 (Rubicon is a joint owner of ArborGen)

18/ ibid.

19/ ibid.

plantations. China is moving forward with plans for more than 13 million hectares of jatropha and other biofuel feedstocks, on sensitive, biologically rich native forestlands in southwestern China.20/

Oil palm is being modified in Indonesia and Malaysia to change the composition of its oil. They also want to increase the oil content of the seeds. Because of its susceptibility to some insects, oil palm is also being engineered for insect resistance and is being engineered for resistance to the herbicide glufosinate.21/ Jatropha is being engineered to increase production and improve the oil content of the seeds.22/

Conclusion

The pursuit of a global energy strategy that features wood as a major agrofuel feedstock on top of the already growing demand for pulp and paper products clearly poses a variety of potential problems. Use of genetically engineered trees for agrofuel and pulp production would significantly increase this risk, with serious implications for the world's forests and forest-dependent peoples.

The already rising demand for wood is accelerating the conversion of native forests into faster-growing tree plantations and escalating rates of illegal logging. Further increasing the demand for wood to feed cellulosic ethanol plants will exacerbate these already serious problems and add to them by increasing the demand for genetically engineered trees. All of this will in turn severely threaten the ecological integrity and biological diversity of native forests, soils, and water, as well as forest-dependent indigenous and rural communities.

This cumulative erosion of the world's forest ecosystems will also have significant impacts on climate, belying the argument that faster-growing GE trees will take the pressure off of native forests or be part of the solution to global warming.

Simply put, genetically engineered trees are one of the foremost threats to forest biological diversity and forest-dependent peoples across the globe.

20/ Yingling Liu, *"Chinese Biofuels Expansion Threatens Ecological Disaster"*, Worldwatch Institute, March 13, 2007, http://www.worldwatch.org/node/4959

21/ UN FAO GMO registry.

22/ Qing Liu, Surinder Singh & Allan Green, "Genetic Modification of Vegetable Oils for Potential Use as Biodiesel," CSIRO Plant Industry presentation, May 2007, http://www.thaijatropha.com/9.pdf