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To the editor:
A news article in the September issue, describing a New Zealand Royal Commission's deliberations on the future of recombinant DNA technology in that country (*Nat. Biotechnol.* 19, 792, 2001), reminded me of a cartoon that is especially apt in this international context. The cartoon depicts a lawyer conversing with his client, a primitive prehistoric warlord, who has just been informed he is accused of pillaging and plundering Paris. "What'll we do," asks the worried client? "I'll try to get it reduced," the lawyer promises. "To what," the other asks? "Pillaging and plundering Helsinki," says the lawyer.

Even if the Royal Commission rejected the absurd measures demanded by extremists—namely, "the idea of branding New Zealand 'clean and green' and free of all genetically modified material"—its assumptions and conclusions leave much to be desired. They all but ignore scientific principles and knowledge as the basis for public policy, and it appears that all of the available options open to the New Zealand government would still be excessively precautionary, discriminate against the use of recombinant DNA technology, and impose upon it what amounts to a punitive tax.

The remit of the inquiry was to cover the whole gamut of scientific, economic, environmental, ethical, indigenous, intellectual property, legislative, and regulatory aspects of the subject. How ironic that, in spite of such a broad mandate, the commission accepted terms of reference too narrow to enable it to get the correct answers.

The commission accepted the pseudo-category of GMOs as a meaningful one, despite scientific consensus to the contrary[1,2]. We should certainly by now consider a "given" that recombinant DNA techniques are an extension (or refinement) of earlier, less precise techniques for genetic modification. Just as we no longer argue about whether Pons and Fleischmann deserve the Nobel Prize for their alleged demonstration of cold fusion or whether water retains "memory" of a solute at infinite dilution, we must get past the pseudo-controversy, false assumptions, and unsubstantiated rhetoric about recombinant DNA technology.

The regulation of risk is complex, to be sure, but if democracy must eventually take public opinion into account, good government must also discount heuristic errors or prejudices. Edmund Burke emphasized governments' pivotal role in making such judgments. He observed that in a republic with leaders elected to represent public interests, "[y]our representative owes you, not only his industry, but his judgment; and he betrays, instead of serving you, if he sacrifices it to your opinion."

Finally, the objective of deliberations of the sort undertaken in New Zealand is to get the right answer, not merely to sample public opinion in an open and egalitarian fashion. Although it may be useful, and also politic, for governments to consult widely on high-profile public policy issues, when the consultations and deliberations have been completed, government leaders are supposed to *lead*. We will soon see if they choose to do so in New Zealand.

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1. Anonymous. *Nature* **356**, 1–2 (1992).
2. National Academy of Sciences. *Field testing genetically modified organisms: framework for decisions.* (National Academy Press, Washington, DC; 1989).

Cheryl Norrie and Liz Fletcher respond:
New Zealand's Royal Commission Inquiry was charged with investigating and reporting on genetic modification and was not bound to accept a "scientific consensus" (if indeed such a consensus exists). The Royal Commission would agree with Miller that its objective was to aim at a "right" answer, and not merely to sample public opinion. Indeed, its chairman, former chief justice Sir Thomas Eichelbaum, explicitly rejected the notion that the commission was conducting a public referendum. The processes of the inquiry were geared toward informing the four commission members (a former judge, a member of the clergy, a general practitioner, and a scientist) as well as consulting with New Zealand's publics—both lay and scientific. Nevertheless, New Zealand deserves credit for allowing the public to air their views and for attempting to develop some consensus on the best way forward. At a time when public confidence in government policies on food and food safety is at an all-time low, no politician can afford to ignore the potential damage inflicted by a disgruntled populace: the GM debacle in Europe is a case in point. However, New Zealand Prime Minister Helen Clark agrees with Miller that in the end, government leaders need to "lead". Questioned over her decision to ignore public antagonism to GMO trials, she said: "There are times when you have to show leadership. A nation that's going to stop its scientists discovering things, is a nation which is heading backwards."

Plotting a course for GM forestry

To the editor:
In recent months, the destruction of transgenic field experiments[1] and the firebombing of our own university offices and laboratories[2] by extremists from the Earth Liberation Front have propelled GM trees into the headlines. Ironically, at the same time that our research was under attack from "ecovandals", we were in the final stages of putting together a two-day symposium* bringing together all sides of the debate for a discussion of the science, ethics, and policy of forest tree genetic engineering.

One of our main goals in convening the meeting was to try to reach a broad consensus on a research agenda that would facilitate the development of transgenic forest trees as an alternative source of wood, fiber, and fuel for human use. Current projections estimate that an *additional* 800×10^6 hectares (25% of the earth's current forest estate) of low-yielding native forest might have to be logged to meet demand by 2050 (ref. 3). This outcome might be avoided with further development of plantation forests and continued improvement in yield of food crops. Indeed, intensification of forestry has the potential to spare the vast majority of native forest from commercial harvest, although this favorable outcome might not be inevitable, especially if the value of wild forests were to decline as a consequence.

While groups on all sides concur on the urgency of conserving forest reserves, there is less agreement on the need for GM technology in enhancing forest intensification strategies. Even here, however, common ground can be found surprisingly easily, as demonstrated at the meeting among scientists with diverse backgrounds and conflicting viewpoints. Overall, broad consensus, if not unanimity, can be found in the following areas:

• If GM forest trees are to play a part in intensification, much more research is needed to assess risks and benefits to the environment. GM forest trees potentially pose ecological problems beyond those faced by transgenic agricultural crops. Forest trees are essentially undomesticated, making escape of transgenics to the wild more probable. The long life span of trees is particularly troublesome for risk/benefit assessment. A meaningful analysis of environmental impact will require at least one full rotation age (from planting to harvest). The notion that transgenic trees, characterized by one or many very highly directed genetic changes, would behave similarly to invasive exotic species appears unlikely because invasiveness is the result of the interaction of many coadapted genes rather than any single gene.

• A broad moratorium on all field research with genetically engineered trees, as Greenpeace has demanded, would be counterproductive and unnecessary. However, there is a minority of scientists who believe that a moratorium on the commercial release of transgenic forest trees would be advisable until more research is done.

• A wide-ranging, inclusive debate is needed to help the public and politicians decide whether genetically engineered plantation forests should be deployed on a large scale. While science can inform all sides of the debate, the ultimate decision about deployment of transgenic forest trees is outside the realm of science.

We believe that ongoing efforts should focus on securing funding in the above areas, as governments clearly will need to finance much more applied and basic research if they wish to see the potential for socially acceptable applications of transgenic plantation trees fully explored.

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**Ecological and Societal Aspects of Transgenic Forest Plantations, Skamania Lodge, Stevenson, WA, July 22–24, 2001 (http://www.fsl.orst.edu/tgerc/iufro2001/eco_symp_iufro.htm).*

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2. Dalton, R. *Nature* **511**, 409 (2001).
3. http://greatrestoration.rockefeller.edu/

Grafting for transgene containment

To the editor:

In recent years, significant effort has been devoted to developing strategies for containment of reproduction for transgenic trees[1–3]. There has been great concern from environmentalists, governmental organizations, and scientists regarding the dispersal of genetic material from transgenic plants through pollen and seeds[4–6]. Solving this problem for forest trees has proved technically challenging, and as yet no general solution has been found. We propose a simple inexpensive method, based on traditional technology, that can establish complete control over reproduction of transgenic trees.

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[7,8]. 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[9,10].

We have devised a method that is particularly suited to study the effects of genetic modification of wood properties. Many studies of transgenic trees are directed to this purpose[11,12]. To study wood formation, the most important component of the tree is the trunk, which usually does not flower. Thus, a transgenic trunk would be sufficient for most studies of genetic modification of wood properties. Most trees do not flower for many years during a juvenile growth phase, and during this period, there is no risk of gene flow. Trees that are grafted with nontransgenic scions at their top before they reach reproductive age, and that have their side branches pruned, will form only nontransgenic reproductive structures. Most of our fruit trees and seed orchards are the outcome of such grafting.

The height of grafting depends on the type of experiment needed. Usually, the height of the trunk needed for study is within reach, and the grafting can be done with ease. The lower part of a grafted trunk does not grow in height after grafting, so that there is no danger of "escape" during the experiment. Containment can be verified at the molecular level using appropriate genetic markers. The upper, flowering part of the tree, which produces nontransgenic pollen and seeds, will not enable flowering of the lower parts because this control is part of their natural biology.

This simple grafting method can also be used to study transgenic effects on root systems of trees. It should be possible, if needed in some species, to control adventitious growth and reproduction from roots by grafting a transgenic shoot to a wild-type rootstalk. Double grafting would make possible simultaneous control of flowering and control of any long-term effect of residual live roots. This method may have application in other crop species, both woody and herbaceous.

The availability of this method should facilitate planning to investigate properties of interesting transgenes in woody plants. Recent genomic studies have discovered many potential transgenes of interest to the wood and paper products industry[13,14]. Grafting would allow these genes to be tested without risk of transgene dispersal so that their biological and commercial properties could be evaluated in moderate-sized field tests.

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