Johnny Appleseed and the Greenhouse

Replanting the forests of the earth could help mitigate global warming; what was once fantasy is now a policy option, but it is still a lot of trees

UNTIL VERY RECENTLY, asking how many trees would have to be planted to mitigate the greenhouse effect seemed not only naïve, but a bit absurd—the kind of calculation more appropriately presented on a cocktail napkin than before a congressional committee. "Everyone thought it was bananas," says Norman Myers, a senior fellow at the World Wildlife Fund.

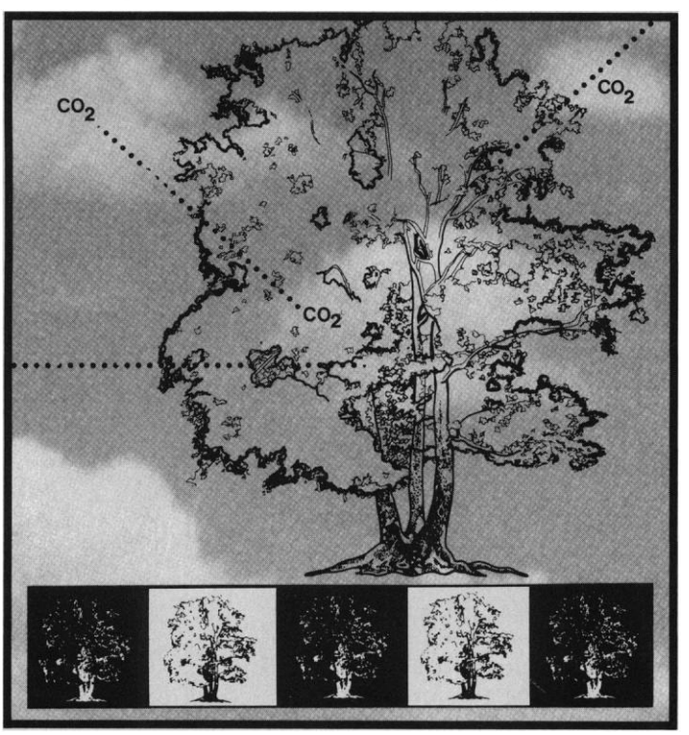
For how many new trees must be planted to absorb the atmospheric carbon that is behind the greenhouse effect? Try to imagine a tree farm the size of Australia. Or one at least as big as Zaire.

Yet the memory of the summer's heat wave, coupled with a sinking feeling that the global warming of the greenhouse effect may already be upon us, has nudged the idea of reforestation toward the realm of the politically palatable. In the past few weeks, two congressional committees have held hearings that touched on the possibility of a massive effort to reforest the planet in order to soak up carbon dioxide, the principal greenhouse gas.

Under the gun to come up with policy options to control global warming, the Environmental Protection Agency is also taking a serious look at reforestation. "In the long run, it might be cheaper than a lot of other options," says Daniel Lashof of EPA. Lashof adds that planting trees "provides for a nice synergism," since trees not only absorb carbon dioxide and store the carbon as woody biomass, but they also slow soil erosion, improve watersheds, provide timber, and shelter a web of biodiversity. This kind of laundry list of dividends is the stuff that legislation is made of. A pair of greenhouse bills, one introduced by Senator Timothy Wirth (D–CO) and another by Representative Claudine Schneider (R–RI), both include language on reforestation.

As Charles Hall of the State University of New York at Syracuse puts it: "I don't know if we're going to be able to significantly alter atmospheric carbon by planting trees, but so what? You haven't hurt anybody by planting trees on marginal lands."

Environmentalists are wasting no time selling the scheme. Daniel Dudek of the Environmental Defense Fund believes that the large producers of carbon dioxide should be required to offset their emissions by planting trees. One company already plans to do just that. Applied Energy Services of Arlington, Virginia, recently contracted with the World Resources Institute in Washington to develop a plan to counter the carbon dioxide emissions from one of its coal-fired power plants in Connecticut with a forestry project in Guatemala.



On a global scale, how many trees would do the trick? The question is only now being addressed. Myers of the World Wildlife Fund has done rough calculations. So has Gregg Marland of Oak Ridge National Laboratory, who recently testified before the Senate energy committee. Marland stresses that his numbers only reach the level of "gross trends" and "orders of magnitude," while Myers calls his own work "very preliminary and exploratory." Though admittedly crude, their calculations do provide a foundation for a discussion of reforestation, while they graphically illustrate the size of the problem.

As a starting point, Marland's projections are based on an attempt to absorb 5 billion tons of carbon from the earth's atmosphere every year. This is roughly the amount of carbon released each year by the burning of fossil fuels. It does not include the more hotly debated figures which describe how much additional carbon is released each year by the clearing and burning of forests in the tropics, a number that is not known with certainty, but could reach several billion tons of carbon annually.

To compute how many trees would be needed to convert 5 billion tons of atmospheric carbon into woody biomass each year, Marland bases his calculations on the carbon-fixing abilities of the American sycamore. Why sycamores? "They were in the literature," Marland shrugs. "They are also good trees with a high value for carbon uptake." Marland concedes that the sycamore is inappropriate for the tropics, where growth rates and carbon uptake could be higher.

Regardless, one hectare of pampered sycamores living on a tree plantation in Georgia can absorb about 7.5 tons of carbon every year. So Marland estimates that we would have to plant 7 million square kilometers of trees to absorb 5 billion tons of carbon per year. This is an area about the size of Australia. Marland also notes that 7 million square kilometers is an area roughly equal to all the tropical forest (but not the woodland) that has been cleared since man took up agriculture some 10,000 years ago.

Some researchers think that Marland's calculations make a case against reforestation, since the task seems almost too enormous. Richard Houghton of the Woods Hole Research Center in Massachusetts points out that we might not actually need to absorb all 5 billion tons of carbon re-

leased by the burning of fossil fuel. If we only wanted to stabilize the greenhouse effect, and not reverse it, we could probably get away with planting enough trees to absorb only 3 billion tons of carbon—since this is actually the amount of carbon that is accumulating in the atmosphere every year. The rest of the carbon released by burning forests and fuel is apparently being absorbed by the oceans and other carbon sinks.

In fact, this more optimistic approach is how Myers does his homework. Myers estimates that the new forests would only have to absorb about 3 billion tons of carbon annually. This assumes that global deforestation is largely halted, a hopeful assumption that Marland does not share in his study. Myers also bases his calculations not on the carbon-fixing ability of the American sycamore, but on a tropical species of eucalyptus or pine, which could absorb about 10 tons of carbon per hectare per year versus the 7.5 tons absorbed by Marland's sycamore.

The bottom line for Myers is that we would still have to plant 3 million square kilometers of trees, an area roughly equal to the landmass of Zaire.

Of course, there is another little problem. Using forests to store carbon is a temporary solution at best. Sooner or later, the carbon stored in the woody mass of trees must be released, says Marland. Even if some of the trees are made into furniture or kept from rapidly rotting, all wood eventually decays, and in the process gives back its carbon. Myers suggests that we might store some of the trees underground or stick them at the bottom of the ocean. Marland thinks the extra trees could be used to generate power, thereby replacing fossil fuels. More study on these options is clearly needed.

Everyone, too, points out that reforestation would only be one of several tools for mitigating the greenhouse effect. And indeed, without stopping or slowing the deforestation that is consuming millions of hectares of tropical forest every year, talking about reforestation seems out of touch with reality. Indeed, in any discussion of reducing greenhouse gases, increasing energy efficiency, and reducing our dependence on fossil fuels usually takes a front seat over reforestation.

Still, in an address before the recent meeting of the American Institute of Biological Sciences in Davis, California, Thomas Lovejoy of the Smithsonian Institution, suggested that reforestation is one way to bring atmospheric carbon under control. But it is not the cure. "What this buys is time—time to develop a better management of energy use and reduction of dependence on carbon-based fuels," says Lovejoy.

■ WILLIAM BOOTH

American Parallel for Oxford Research

Biochemistry and pharmacology departments find funds and model for research arrangements in United States

Oxford

OXFORD UNIVERSITY, like most other universities in Britain, has been looking for industrial funding in recent years to help make up for declining support from the government. So far, it has found some of its biggest supporters across the Atlantic.

Last fall, the U.S. pharmaceutical company E. R. Squibb announced that it was making a 7-year, $34-million research grant to Oxford's Department of Pharmacology to support long-term research into various aspects of the influence of chemicals on the activity of the brain.

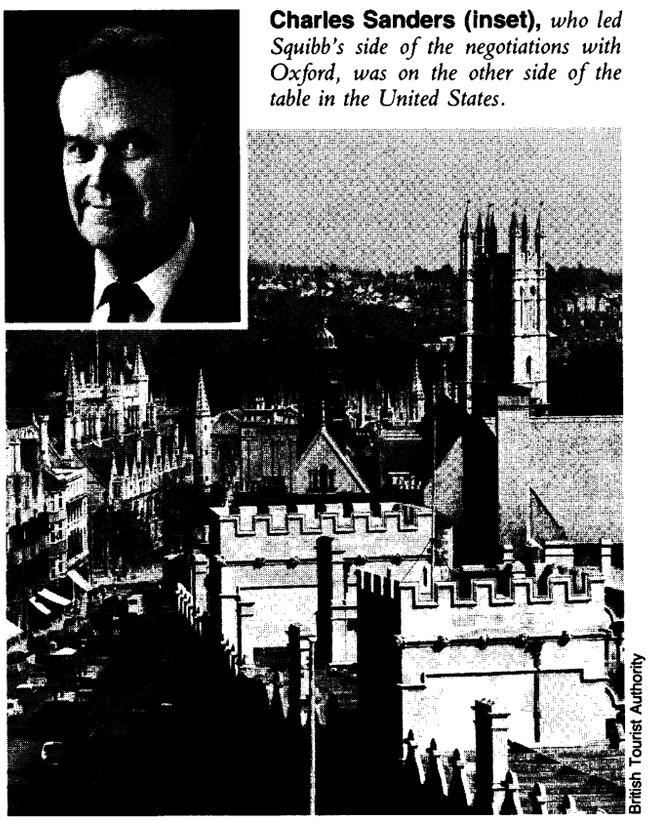
The grant, the largest of its type ever awarded to the university, is similar to a $50-million grant received by Massachusetts General Hospital from the West German company Hoechst under an agreement reached in 1980. The resemblance is not mere coincidence.

Pharmacology professor David Smith, who was largely responsible for attracting the U.S. money to the department, says that the terms of the arrangement are based, albeit loosely, on those of the Hoechst/MGH deal (which he says he gleaned originally from an article in *Science*, 11 June 1982, p. 1200). Moreover, Squibb's side of the negotiations were led by the company's executive vice president for science and technology, Charles Sanders. It was Sanders who, in his former position as general director of MGH, was largely responsible for negotiating the U.S. medical school's arrangement with Hoechst.

The Squibb grant follows a path first explored at Oxford by another U.S. company, Monsanto. Five years ago, Monsanto made a long-term grant, currently worth about $2 million a year, to scientists working in the university's department of biochemistry on the structure and functioning of the sugars attached to proteins.

Both grants are relatively unusual for Britain in that—like the Hoechst arrangement with MGH—the companies have not specified in advance particular problems they want solved or drugs that they need help in developing. Instead, they are leaving the choice of research topics up to the scientists they support. In return, the companies will be given the rights to any potentially profitable results to emerge.

The Monsanto-sponsored research has already led to several patented inventions, such as tissue plasminogen activator that includes, for the first time, in a patent a detailed description of the sugars attached to the TPA molecule. It has also spawned a novel arrangement for commercializing the research. The university, Monsanto, and the researchers themselves each have an equity



Charles Sanders (inset), *who led Squibb's side of the negotiations with Oxford, was on the other side of the table in the United States.*

British Tourist Authority