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Biological Carbon Sequestration

The eminent mathematical physicist and writer Freeman Dyson is known for his optimism about technology and bold thinking. Dyson recognizes global warming caused by human activity as a challenge, but maintains that within a few decades we will be able to control it. Dyson has long argued, most recently in *The New York Review of Books*, that genetically engineered trees might, as well as producing biofuel, combat climate change. He notes that about 8 percent of the carbon dioxide in the atmosphere is temporarily converted into vegetation each year by photosynthesis. Capturing some of this with trees designed and harvested for the purpose could, he suggests, reduce the amount of that gas in the air rather quickly, and so ameliorate greenhouse warming.

Ecologists are apt to see enormous problems with Dyson's notion—for example, the loss of agricultural land that would presumably result from creating vast plantations of such trees; the energetic costs of planting, harvesting, and producing fertilizer for the trees; the amount of water needed for irrigation; and the large-scale disruption of existing ecosystems. It is also unclear how much potential for improving carbon fixation rates there may really be. Not least of all, the idea seems sociologically naive. Some 12 percent of the annual net increase in atmospheric carbon dioxide is the result of deforestation. If we can't prevent existing forests from being destroyed, how can we persuade people to plant forests of genetically modified trees?

Still, serious problems demand that attention be given to all possible solutions, and few biologists would rule out some future role for enhanced biological carbon sequestration, whether by trees or other organisms. Moreover, genetically engineered food crops are already widely grown, so planting crops engineered to sequester carbon seems hardly the most ambitious of the warming mitigation options now being discussed. *BioScience* therefore invited several scientists with relevant expertise to contribute to this issue's Special Section on biological carbon sequestration.

Our authors have a range of perspectives on the topic. They include some (Christer Jansson and colleagues, and Steven H. Strauss and his coauthors) who are pursuing the prospects for genetically engineered trees that might one day contribute to amelioration of global warming—if they can meet safety requirements for testing. Richard Sayre outlines the possibilities for cultivating algae as biofuel feedstock. Others (Robert B. Jackson and Justin S. Baker, and Rattan Lal) analyze the big-picture ecological and economic constraints on expanding sequestration in forests and in soil generally through agriculture. Emily Boyd discusses societal understanding of the choices that large-scale enhanced biological carbon sequestration would necessarily bring, and considers how they could play into economic development.

There are substantial impediments to using genetic engineering to increase carbon removal from the atmosphere on a significant scale, and there are dangers. It might at best be a partial solution. But the right combinations of technology and economic incentives have overcome daunting obstacles in the past. In light of the continuing lack of political progress toward reducing carbon emissions—and the dangers of inaction—the possibilities deserve thorough, continuing evaluation.

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