Let me close with a brief quantitative summation of 3 recent studies and what they envision as possible or likely. Bob Moulton and Ken Richards (1990) of the U.S. Forest Service suggest that the U.S. could offset 56.4% of current CO_2 emissions with tree planting on "economically and environmentally marginal pasture and crop land and non-federal forest land." This would involve 140 million hectares, of which 30 million hectares are already forest land. The National Academy of Sciences (1991) takes a conservative approach in evaluating the Moulton and Richards data and suggests that a reasonable initial objective would be a 10% offset of current U.S. CO_2 emissions on 28.7 million hectares. The NAS study also considers replacing 2.4 quads (2.5×10^{18} joules) of fossil-fuel-fired electric power with biomass. The Office of Technology Assessment (U.S. Congress 1991) estimates that through a combination of planting trees on Conservation Reserve lands, increasing productivity, planting urban trees, general afforestation, and biomass energy the U.S. "might be able to offset about 2% of U.S. 1987 carbon emissions...in the year 2000 and 7.5% in 2015". They envision that economic opportunities for tree planting may exist on about 30 million hectares.

My conclusion is that where we can combine high yields with efficient harvest and conversion, energy crops should offer an attractive long-term contribution to reducing global emissions of CO_2. Where yields are lower and/or harvest more difficult, increasing forest area or improving forest management could provide a temporary brake on the growth in CO_2 emissions. In other areas, carbon storage may provide an added incentive to protect and preserve mature forests. The distinctions will depend on relative values of standing crop, achievable yield, and harvest cost. We are just beginning to get a realistic view of the possible magnitude of the contribution. The challenge is how to incorporate carbon fixation and storage as a management objective while maintaining a balance among other forestry management objectives.

LITERATURE CITED

America's Climate Change Strategy: An Action Agenda, 1991. A document published under the seal of the President of the United States for the first session of the Intergovernmental Negotiating Committee on Climate Change, Chantilly, Virginia, Feb. 4, 1991.

Barnola, J.M., D. Raynaud, Y. S. Korotkevich and C. Lorius, 1987. Vostok Ice Core Provides 160,000-year Record of Atmospheric CO_2. *Nature*, v. 329, p. 408-414.

Botkin, D.B., 1991. Global Warming and Forests of the Great Lakes States: An Example of the Use of Quantitative Projections in Policy Analysis. First prize paper, The George and Cynthia Mitchell International Prize for Sustainable Development, presented March 3-6, 1991, The 1991 Woodlands Conference, HARC Center for Growth Studies, The Woodlands, Texas.

Brubaker, L.B., 1986. Responses of Tree Populations to Climatic Change, *Vegetatio*, v. 67, p. 119-130.

Dale, V.H., R.A. Houghton, and C.A.S. Hall, 1991. Estimating the Effects of Land-use Change on Global Atmospheric CO_2 Concentrations, *Canadian J. Forest Res*, v. 21, p. 87-90.

Elliott, P. and R. Booth, 1990. Sustainable Biomass Energy, Selected Papers, Shell International Petroleum Company Ltd., London.