Warming Shouldn't Wither U.S. Farming

Global warming in the next half-century should not seriously damage U.S. agriculture as a whole, although it may hurt farming in some states, according to the first comprehensive study to address how climate change will affect agriculture in the United States.

"The U.S. agricultural sector appears to be relatively resilient. We don't see major catastrophic effects on the welfare of producers or consumers of agricultural products," reports economist Richard M. Adams from Oregon State University in Corvallis.

Because of significant economic and scientific uncertainties underlying the issue of climate change, the study cannot yield firm predictions. Depending on the magnitude of climate change, U.S. agriculture might gain or lose, the researchers say. But even modest precipitation changes and temperature hikes should drive a general northward shift in the farming of current crops, Adams and his nine coauthors conclude in the May 17 NATURE.

In the projections, "some regions are particularly hard hit," Adams says. "Some areas have a potentially large amount of land shifting out of production, and that would translate into fairly sizable economic consequences in those regions." Other scientists contend farmers may be able to adapt by using different techniques or crops.

The new study started with two climate models that project how regional temperatures, rainfall and evaporation would change with a doubling of atmospheric carbon dioxide, which could effectively occur by 2030 due to increasing concentrations of many greenhouse gases. One model predicts relatively mild U.S. changes, while the other shows greater warming and loss of precipitation.

The team fed these results into agricultural models that simulate how wheat, corn and soybean crops would respond to climate changes. Because carbon dioxide fertilizes such plants, the growth models include a factor that increases photosynthetic rates in the double-carbon-dioxide world. The output of such simulations was then fed into an economic model for U.S. agriculture.

The results show that in the mild climate-change scenario, the fertilization factor offsets the adverse climate effect, and agricultural yield increases in most areas, Adams and his colleagues report. That translates to a net gain of more than $10 billion for agricultural producers and consumers in the United States, they say. With more severe climate change, crop yields tend to drop, causing a net loss of about $10 billion, borne mostly by consumers. Such changes amount to about 8 percent of the 1982 market value of U.S. crop and livestock production.

In either scenario, the demand for irrigation increases in most areas, potentially causing water supply problems, the authors point out.

Though the study represents an important first attempt, it has some clear limitations. Economist John Reilly of the U.S. Department of Agriculture notes that the economic projections could differ significantly if the analysis included global market forces and the impact of climate change on the rest of the world. Moreover, he asserts, the study does not realistically allow for farmers' adaptations, which might prevent agriculture from shifting northward.

On the other hand, plant scientist Cynthia Rosenzweig of the Goddard Institute of Space Sciences in New York City, who coauthored the new report, cautions that if drought frequency increases — a possibility not fully considered in the study — global warming will have much more severe economic effects on U.S. agriculture and society in general.

Joel B. Smith of the Environmental Protection Agency, which funded the project, says it demonstrates that increasing carbon dioxide levels will not necessarily improve agricultural yield, as some have suggested. "I think it points out some of the risks of global warming," he says. — *R. Monastersky*

Compound inhibits vessel growth, cancer

Using a genetically engineered protein that blocks the formation of new blood vessels, scientists have successfully inhibited the growth of cancerous tumors in mice. The work provides some of the clearest evidence yet that physicians may someday starve solid tumors to death with drugs that cut off a cancer's blood supply.

Twenty years ago, Harvard University's Judah Folkman proposed that tumor cells somehow trigger angiogenesis — the growth of new blood vessels — to fulfill their ravenous appetites and to wash away their accumulated wastes. Scientists have since identified several tumor-secreted factors that cause specialized cells, called endothelial cells, to organize into such capillary "water and sewage lines" in tumorous neighborhoods within the body. But the search for anti-angiogenic factors — which would inhibit vessel formation — has progressed slowly. Until recently, the few candidates studied in cell cultures and in animals have shown worrisome toxicity at concentrations that suppress angiogenesis.

Earlier this year, researchers at Repligen Corp. in Cambridge, Mass., showed that a genetically engineered version of a protein normally found in human platelets inhibited angiogenesis when applied to chick embryo membranes. They suggested that the protein, platelet factor-4 (PF4), had potential as a tumor-starving agent. Now, in the May 16 JOURNAL OF THE NATIONAL CANCER INSTITUTE, the researchers prove their hypothesis true.

Repligen scientists Richard J. Sharpe, Theodore E. Maione and their coworkers transplanted mouse melanoma cells and human colon carcinoma cells into mice, then compared tumor growth in mice that did and did not receive daily PF4 injections. The compound prevented the cancer cells from growing into tumors, the team reports.

Although a few other anti-angiogenic molecules have suppressed tumor growth in animal experiments, they have for the most part triggered a wide array of biochemical side effects. In contrast, experiments so far suggest that PF4 does nothing but prevent the local migration and proliferation of vessel-forming endothelial cells. Since new vessel formation is virtually absent in adults except during wound healing or following ovulation, the researchers anticipate few ill effects from angiogenesis suppression in cancer patients.

Maione says his group is now experimenting with an altered version of PF4 that persists longer in the blood than the current version. If further experiments confirm its value, he says, the team will seek FDA permission this year to give it to people with Kaposi's sarcoma, a cancer-like proliferation of endothelial cells.

"We're finally learning the rules of anti-angiogenesis," says Folkman, who is looking into a promising anti-angiogenic substance derived from a fungus. In addition, Noël P. Bouck of the Northwestern University Medical and Dental Schools in Chicago says she and her colleagues will soon publish details about an anti-angiogenic protein they discovered in blood platelets last year. And Harvard's Robert S. Langer and Marsha A. Moses will describe a cartilage-derived anti-angiogenic factor in SCIENCE this summer. — *R. Weiss*