OTA REPORT

GAINS, HARDSHIPS TO STEM FROM AGBIOTECH

NEW YORK—It is not news that America's small farmers are in financial trouble. That biotechnology will add to this problem, however, is the message of a new report from the Office of Technology Assessment (OTA).

Called *Technology, Public Policy, and the Changing Structure of American Agriculture*, OTA's latest tome concludes that by adopting new technology, U.S farmers should be able to keep up with the country's own demand for agricultural products, and meet the world demand as well. American farmers would also compete better in the international marketplace, while at the same time decreasing land and water requirements.

But a price will be extracted from the small farmer: biotechnology represents yet another force leading toward centralization and vertical integration. By the year 2000, the report predicts, as few as 50,000 large-scale farms could account for 75 percent of the country's agricultural production.

In a kind of agricultural triage, OTA concludes that the large farms need little help from the government to survive; moderate-sized farms can be helped through pricing, loans, and other public sector assistance. But, according to the report (p.23), "With few exceptions, small farms, those having less than $100,000 in sales, are not viable economic entities in the mainstream of commercial agriculture—nor can they be made so." Price and income support programs have not helped small subsistence farmers, so OTA recommends social, educational, and financial programs specifically tailored to their needs.

The OTA study points to some 150 biological and information technologies that will affect farming. Advances such as embryo transfer, gene insertion, and the use of growth hormones will improve animal production. Later, plant agriculture will be bettered by engineered disease and insect resistance, higher protein content, and self-production of fertilizer and herbicide. "Impacts on plant production," the report states (p.10), "will take longer, almost the remainder of the century....However, the impacts of these technologies will be substantially greater for plant agriculture after 2000."

The study forecasts that 70 percent or more of the large farms will adopt some of the biotechnology and information technologies now being developed, as contrasted with only 40 percent of moderate-sized farms and 10 percent of small farms. OTA states (p.216): "The panel concluded that the new technologies were most likely to receive first adoption by farmers who were well financed and were capable of providing the sophisticated management required to make profitable uses of the technologies. In the main, such farmers will tend to be those with relatively large operations."

As new technologies increase productivity and thereby force the prices of agricultural products down, the small farmer with tight margins will be hurt the worst. Perhaps the most dramatic such example is expected to occur in the dairy industry, where the OTA predicts that growth hormone treatment and other technological advances will increase the milk production per cow about 3.9 percent annually through the year 2000. Because there is a milk surplus already, this will further erode the price of dairy products.

"It's a matter of the new plant genetics contributing to consolidation, not being the sole causal factor," says George H. Kidd, advanced science consultant for L. William Teweles (Milwaukee, WI). Because they buy more seed at cheaper prices, large farms find themselves in a better position than small ones to take advantage of options such as improved strains. "It's not the percentage increase in production that's crucial," says Kidd. "It's the increase in gross revenues that the farmer sees." So, in the long run, economies of scale mean that *any* improvement in productivity can be viewed as another nail in the small farmer's coffin.

Interestingly, research from Iowa State University (Ames) indicates that it is the financially strapped farmers—at least in that state—who are most receptive to high-tech improvements. (Whether the farmers actually would *buy* such technology may be another story.) When queried about DNA research specifically, the farmers' age, education, size of farm, and financial status did *not* statistically alter their support. Presenting his findings at a recent Business Communications Co. (Stamford, CT) conference on commercial biotechnology, Iowa State's Paul Lasley noted that many biotechnological advances affect farms in a "size neutral" manner, and that the first farmers to adopt improved technology will reap the early rewards. "But farmers have trouble realizing that the benefits of technology are not evenly distributed," Lasley cautioned.

Despite its social reservations, the OTA report concludes optimistically (p.294): "The substantial costs of these improvements to farming and rural communities can be minimized by careful policy analysis, planning, and implementation."

—Arthur Klausner

MEETING REPORT

FILAMENTOUS FUNGI JOIN THE PRODUCTION RANKS

WASHINGTON, D.C.—The list of eukaryotic organisms with the potential for industrial production of bioengineered compounds now includes filamentous fungi as well as yeast and mammalian cells.

Wayne Davies (Allelix, Mississauga, Ontario) reported here at the 86th Annual Meeting of the American Society for Microbiology that two species of *Aspergillus* appear to be efficient eukaryotic hosts. Both *A. niger* and *A. nidulans* secrete high levels of protein; they also are able to perform such post-translational events as glycosylation and protein folding. *A. niger* is already an industrial organism, used for organic acid and enzyme production. *A. nidulans* already has well-characterized genetics and defined promoters.

Davies explains that for an expression-secretion system to be truly functional there are two essential components. One is the vector into which the coding region of choice is inserted; the other is a system for introducing the construct into the host genome in an expressible form. Davies' group has concentrated on making vectors that contain a signal peptide sequence fused to a promoter with a number of sites downstream from the signal where a series of coding regions can be inserted. The *A. nidulans* promoter they used was the promoter for the *alk*A gene, one of three genes involved in ethanol metabolism. *Alk*A encodes an ethanol-inducible ADH1 gene, and *ald*A encodes an aldehyde dehydrogenase. Both require the presence of a posi-