Biotechnology to change farm landscape

Amidst a period of change and stress in U.S. agriculture, new forces — biotechnology and information technology — are entering the field. What effect will they have? A study by the congressional Office of Technology Assessment (OTA) predicts that in the next 14 years agricultural productivity will increase significantly, but the structure of agriculture will change dramatically. Approximately 1 million farms, most of small or moderate size, will disappear, OTA says. In the year 2000, only 50,000 large farms will be required for 75 percent of all U.S. agriculture. In contrast, today there are about 2.2 million farms, of which approximately 650,000 are responsible for 75 percent of agricultural production.

Of the emerging technologies, biotechnology is expected to have the largest impact. The greatest yield increase is expected for dairy production (SN: 4/5/86, p. 213), followed by wheat, soybeans, corn, rice and cotton. Biotechnology will enable agricultural production to become more centralized and more integrated with product processing, says the OTA. It also predicts increased product homogeneity.

The largest farms — those with annual gross sales of more than $250,000 — are expected to adopt the most new technology and accrue the greatest economic advantages. Unless there are "substantial changes in the nature and objectives of farm policy," the report says, the traditional moderate-size farm with sales of $100,000 to $250,000 "will largely be eliminated as a viable force in American agriculture." To preserve such farms and the rural lifestyle dependent on them, OTA proposes hastening the introduction of new technology on these farms and increasing their access to new markets. Small "subsistence" farms are expected to persist, but, the report says, "they will continue to fester as an unaddressed social concern."

How physicists feel about SDI

A telephone survey of 549 American Physical Society members, selected at random from a list of about 37,000 members, indicates that by a ratio of 54 percent to 29 percent (the rest being unsure or seeing no effect) the nation's physicists view the Strategic Defense Initiative (SDI) "as a step in the wrong direction for America's national security policy," according to Washington, D.C.-based pollsters Peter D. Hart Research Associates, Inc. Among those who reported the most familiarity with SDI-related issues, the ratio was even higher: 63 percent thought the so-called "Star Wars" program was bad for U.S. policy. The survey was conducted for the Union of Concerned Scientists, a public-policy group based in Cambridge, Mass., that has been critical of the SDI program.

Even among those physicists who receive a majority of their research funding from the Defense Department, most disapproved of SDI (42 percent versus 38 percent). However, this general disapproval of SDI as national security policy did not reflect a general disapproval of research into SDI-related technologies. Some 77 percent of those polled supported continuing basic laboratory research on the technologies, though most strongly opposed actual deployment of SDI systems.

Among other survey findings:

- 63 percent of the respondents agreed with the statement that SDI "would be dangerously unreliable — since the system as a whole could never be adequately tested."
- While only 3 percent believed an SDI system could be delivered for less than $100 billion (most expected the total to exceed $500 billion), "there was no consensus that it would be worth the cost even at this amount," the pollsters report.

The Union of Concerned Scientists concludes that its survey shows "profound and pervasive skepticism toward SDI in the scientific community."

Putting a molecular race in reverse

Gel electrophoresis is a commonly used method for separating large organic molecules such as nucleic acids. This technique separates ions by size as they migrate through a gel under the pull of an electric field. Usually, smaller molecules travel more quickly. But it doesn't work for molecules larger than a certain size because these bigger ions all travel at the same rate. Now a team at the Washington University School of Medicine in St. Louis has discovered that periodically reversing the electric field separates much larger molecules than before. Their report appears in the April 4 SCIENCE.

Still puzzling, however, is why the method works. "The physical and chemical theory of electrophoresis is poorly developed," says geneticist Maynard V. Olson, who led the development of the new technique. Scientists have postulated that small molecules, which roughly match the size of gel pores, seem to shift from one pore to the next as they migrate in the direction of the electric field. Longer molecules apparently wind through the gel in a snakelike motion. Because a molecule's tail is just dragged along, the speed of this type of motion would be largely independent of a large molecule's total length or size.

This conventional view isn't quite right, says Olson. It doesn't distinguish between the front and back ends of a molecule; if the electric field were reversed, this theory would predict that the molecules would simply go backward. Instead, Olson found that by reversing the field at just the right rate, he could even stop the motion of particular molecules. "It's quite a dramatic phenomenon," he says.

What may be happening is that large molecules need time to rearrange themselves before traveling in a new direction. It's possible, says Olson, that these molecules form into a narrow wedge pointing in the direction of travel. That wedge has to reform when the electric field is reversed. Caught by such a reversal, some molecules react more quickly than others. Thus, periodic electric field reversals make it possible to spread out the rate at which large molecules of different sizes migrate through a gel.

Although how the field-reversal method works is still unclear, it has already been useful for separating components of mixtures that contain DNA segments made up of a million or more base pairs. Conventional electrophoresis works with nucleic acids made up of fewer than 20,000 or so base pairs.

Wiring imperfect crystals

Thin metal strands, only a few atoms thick, can be deposited within silicon wafers to create an extremely fine wiring network, say researchers at Ohio State University in Columbus. The key step involves bonding copper to tiny imperfections deliberately introduced into silicon crystals.

Metallurgical engineer William Clark and his colleagues start the process by welding together two thin slices of crystalline silicon. If the evenly spaced rows of atoms in the two slices are aligned precisely, then the crystals bond perfectly and the boundary disappears. But if the slices are even slightly misaligned, a grid of dislocations is formed at the boundary.

Clark and his team then coat the misaligned crystal sandwich's surface with a layer of copper. Heating the coated sandwich allows copper atoms to diffuse into the crystal's interior. The atoms tend to settle in the dislocations, creating a web of metal filaments.

Wires this small may have all sorts of unusual properties. "There is evidence for some rather strange diode behavior in arrays like this," says Clark. "It does funny things that you wouldn't expect." Yet unsolved is the problem of connecting such arrays to an electric circuit so that they can be used, perhaps for storing information.