Environment

Water scarcity threatens food in the '90s

The world is growing increasingly reliant on irrigated agriculture for its food. Irrigated lands, which account for only 17 percent of the area under cultivation, today yield one-third of the global harvest, notes Sandra Postel, a senior researcher with the Worldwatch Institute in Washington, D.C. Through most of the 20th century, per-capita irrigated agriculture expanded faster than world population. But that trend peaked in 1978, and in the years since, the global per-capita acreage devoted to irrigated agriculture has dropped by 6 percent. Moreover, a number of factors seem likely to hold or further depress the per-capita irrigated average, jeopardizing world food supplies in the coming decade, Postel reported in a study released last week.

The costs of developing new irrigation systems are increasing everywhere, she found. In India, for example, costs of surface-water projects "more than doubled" between 1950 and 1980. Meanwhile, Postel notes, the world's major financers of Third World development projects cut their lending for water projects by 60 percent between 1977 and 1988. And money is sorely needed, she says, not just to expand irrigation but also to maintain existing systems. Postel found that some 60 percent of all current irrigated systems need some form of upgrading, much of it to counter salinization (SN: 11/10/84, p.298).

The search for affordable water is prompting farmers from Texas to China to overpump groundwater at nonsustainable rates, she says. In the rich fruit-and-vegetable basket of Soviet Central Asia, farmers have diverted so much water that the surface area of the Aral Sea — the world's fourth-largest lake — has shrunk by 40 percent since 1960. And throughout the world, cities are diverting irrigation water to slake the thirst of their growing masses. Postel says she suspects the water crisis will come to a head first in Egypt, where water supplies just barely meet demands and a population of 55 million is growing by another million every eight months.

To cope, she recommends that governments consider: reducing water subsidies, which discourage conservation of this limited resource; parceling out irrigation water more conservatively; targeting more funds toward boosting crop yields on rain-fed lands; and limiting population growth to slow the growing demand for the globe's tightening water supplies.

Cigarettes: The low-tar irony

Tobacco companies developed low-tar cigarettes to reduce the hazards of smoking. However, a new study suggests that smokers who switch to low-tar brands may actually increase the health risk posed to their nonsmoking neighbors.

Researchers at the USDA's Tobacco Quality and Safety Research lab in Athens, Ga., collected smoke emitted by each of 16 low-tar cigarette brands (ranging from 1 to 10 milligrams of tar) and compared it with smoke from a high-tar (23 mg) brand. Using the Ames test, the team assayed the smoke's mutagenicity, a rough gauge of carcinogenicity. As expected, the mainstream smoke — the portion inhaled by the smoker — collected from low-tar cigarettes induced 20 to 30 percent fewer mutations per mg of pollutants in the test system's growing bacteria than did mainstream smoke from the high-tar brand.

The surprise came in the sidestream smoke — the portion spewed into room air as cigarettes burn between puffs. In low-tar brands, this proved 20 to 30 percent *more* mutagenic on average than the sidestream smoke of the high-tar cigarette, reports chemist Orestes T. Chortyk, who directed the work. One possible reason, he suggests, is that low-tar cigarettes may release more of their mutagens through the burning end rather than the filtered tip. The researchers found no consistent safety trend among the low-tar brands: Those with the least tar could be every bit as mutagenic as the those with the most.

Materials Science

Ivan Amato reports from Boston at the fall meeting of the Materials Research Society

Sweet semiconductor snags bacteria

Sugar does a lot more than sweeten your coffee. A diverse cast of sugar molecules play pivotal roles in virtually all cellular functions, including metabolism and reproduction. Cellular, bacterial and viral surfaces also don sugar polymers, or polysaccharides, which perform many functions in biochemical communications.

Chemist Mark D. Bednarski and his co-workers at the Lawrence Berkeley (Calif.) Laboratory are now commandeering sugar-manipulating enzymes to assemble laboratory-modified sugar components into new polysaccharides. "We want to combine both chemical and enzymatic methods to custom-design polysaccharide-based materials," Bednarski says. Their goals include using the materials in biosensors that detect specific microbes even in complex biological fluids.

In one project, the researchers use the cellular enzyme glycogen phosphorylase — which normally liberates glucose units from huge, energy-storing starch molecules called glycogen when the cell needs more fuel — to run the reaction in reverse using a laboratory-made glucose derivative. The result: a polysaccharide built of enzyme-linked, fluorine-containing sugar units. The fluorine atoms should serve as accessible sites for a variety of subsequent chemical modifications, they say.

In another project, the researchers first attach long carbohydrate chains to cyclic sugar molecules and then chemically tether the sugar-tipped assemblies to silicon and other semiconducting surfaces. They hope to use the initial sugar coating as a foundation for building more complex chemical layers. Bednarski says the group now is using these principles to develop a new class of biosensors riddled with chemical structures that serve as specific receptors to detect viruses or bacteria such as *Salmonella*.

Lab-made proteins stretch like life

By the time a person reaches the age of 60, some of the elastic fibers in the aortic arch of his or her heart have survived about 2 billion stretch-relaxation cycles, notes molecular biophysicist Dan W. Urry of the University of Alabama at Birmingham. The fibers are made of an unusually long-lived and stretchy structural protein known as elastin.

Urry has been making his own versions of bioelastic proteins since the early 1970s, when he received a call from a colleague who had just uncovered elastin's molecular structure — a repetitive arrangement consisting largely of units of the amino acid string valine-proline-glycine-valine-glycine. Some of his synthetic bioelastics are undergoing animal testing for potential use in preventing scarring after abdominal surgery. Urry and his colleagues start by chemically linking many of these or similar units, which subsequently fold into Slinky-style coils. They then use gamma rays to cross-link the molecules into strips, sheets and other shapes. By slightly altering the composition of the component peptides, the researchers can engineer bioelastics that stretch and contract in response to different environmental cues. "You can drive the elastomers between folded [contracted] and unfolded [stretched] states using thermal, mechanical or chemical influences," Urry says.

Most recently, the team has figured out how to fashion the material into a transparent form that is about as refractive as ocular lens tissue. Urry, who recently formed a company called Bioelastics, Inc., with several University of Alabama colleagues, says he hopes eventually to develop the material as a lens replacement. Closer to the surgeon's shelf, however, are the bioelastic sheets for preventing the scar tissue formation that often occurs after abdominal surgery. Such scarring, called adhesions, can lead to postsurgical complications such as blocked intestines.