UPENDING THE TRADITIONAL FARM

Cities are taking over farmland. Could they someday take over the job of farming, too?

IN A HIGH-TECH ANSWER TO THE "LOCAL food" movement, some experts want to transport the whole farm—shoots, roots, and all—to the city. They predict that future cities could grow most of their food inside city limits, in ultraefficient greenhouses.

"Vertical farms," proponents say, could produce more food using a fraction of the resources that traditional farms consume. The lives of millions of people may depend on it. Dickson Despommier, a parasitologist at Columbia University and an avid proponent of vertical farming, calculates that with projected population increases, the world will need 1 billion more hectares of arable land by 2050—roughly the area of Brazil and far more land than will be available.

Researchers are now putting prototypes of intensive urban farms to a real-world test. The basic concept is an evolution, not a revolution, of greenhouse technology. Greenhouses “can grow any crop anywhere at any time—at a cost,” says Gene Giacomelli of the Controlled Environment Agriculture Center at the University of Arizona in Tucson, which has built a $450,000 greenhouse for researchers who winter at the South Pole. Well-designed greenhouses use as little as 10% of the water and 5% of the area required by farm fields, says Theodore “Ted” Caplow, executive director of the engineering company New York Sun Works in New York City, which designs energy-efficient urban greenhouses.

“We are removing that footprint from the countryside,” he says, and reducing pressure on habitats and depleted soils. Urban indoor farms can’t do it all. Growing grains such as wheat, corn, and rice indoors does not save as many resources as growing vegetables and fruits indoors, says Caplow, and most trees grow too slowly to make greenhouse orchards pay off. Some of the more ambitious concepts for vertical farms will require technological breakthroughs in lighting and energy consumption. And initially, at least, urban produce will likely be more expensive than that grown at conventional farms and shipped to a city.

But as oil prices rise, greenhouse economics look more favorable, Giacomelli says. “All our cheap food is based on cheap transportation, cheap water, and cheap energy for nitrogen-based fertilizer,” he says.

One approach that could be implemented quickly is rooftop greenhouses. In a demonstration of what can be grown on New York City’s roofs, Caplow’s company last summer built and operated the Science Barge, a floating greenhouse on the Hudson River that used solar power and recycled water to grow fruits and vegetables. New Yorkers eat 100 kilograms of fresh vegetables on average per year, Caplow says, and the rooftops of New York City would provide roughly twice the needed space to supply the entire city. New York Sun Works is now installing a demonstration greenhouse on top of a New York City school that would serve as a teaching area and supply produce to its cafeteria.

A more ambitious concept is farming the facades of office buildings. Double-glass facades are already popular among architects as an energy-saver, allowing winter sun in while insulating against noise and heat loss. In the summer, most double facades have built-in shades to keep the interior cool. Hydroponic gardens could provide that shade, Caplow says. Vertical conveyor belts could cycle plants to the lower floors in time for harvest. “The systems we are designing are what we can actually do today,” Caplow says.

Gazing further into the future, Despommier and his students are refining the idea of skyscraper farms. They estimate that a 30-story farm on one city block could feed 50,000 people with vegetables, fruit, eggs, and meat. Upper floors would grow hydroponic crops; lower floors would house chickens and fish that consume plant waste. Heat and lighting would be powered by geothermal, tidal, solar, or other renewable energy sources. Nitrogen and other nutrients would be sieved from animal waste and perhaps from the city sewage system. “That’s where a significant fraction of your fruits and vegetables are going,” into sewage, Despommier says. “You have to close the loop.” Eventually, he says, hydroponic greenhouses could
also be a boon for the developing world. In tropical regions, they could make use of ample sun, conserve water, and give worn-out soils a rest. Ideally, they would also provide a way to safely turn human waste into plant food, he says.

Such ideas are inspiring, says Jan Broeze, an agricultural scientist at the University of Wageningen, the Netherlands. But “you need large technological breakthroughs” in lighting and waste processing to realize them. In 2001, Broeze, Peter Smeets, and their colleagues proposed a six-story urban farm called Deltapark at Rotterdam harbor that would recycle water and nutrients and use excess heat from nearby buildings. The agricultural ministry supported Deltapark, but the project was abandoned after the press criticized it for being “too industrialized.” Now Broeze is working on several projects that link greenhouses with livestock producers to recycle waste and reduce energy consumption. And he and other Dutch scientists are working with colleagues in India and China to design urban farms in several cities. The biggest project is part of Dongtan Eco-city, near Shanghai (see p. 740).

One goal of Dongtan is to grow enough food to replace lost productivity as farmland is urbanized, says Peter Head, director of Arup, a design company leading the project. “The big question is whether it is economically viable,” he says. Head predicts that the lessons learned in China will propel a fundamental shift in the world’s approach to agriculture. “It isn’t a matter of whether we think it would be nice to do urban farming or not,” he says. “It’s a matter of whether we are going to survive.”

—GRETCHEN VOGEL

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