Vertical Farming: Will We Ever "Grow Up"?

By: Lisa Jancarik

The United Nations estimates the world population at about 9.1 billion people by 2050. According to U.N. Food and Agriculture, that population will mean current food production must increase by 70%. Both higher crop yields and larger spaces for planting will be necessary. Of these 9.1 billion people, 70% of them will be living in urban areas, far from traditional-looking farms.

Our current long-distance transport arrangements for supplying food to population centers face some serious problems presently, including spoilage, fuel consumption and carbon dioxide emissions. Vertical farming in the midst of cities has the potential to limit these difficulties according to Dickson Despommier, a professor of public and environmental health at Columbia University in New York.

Despommier wrote The Vertical Farm, a manifesto of sorts for the idea. Vertical farming is the farming of plants on multiple floors of a skyscraper. The goals are to conserve soil and land and to make agriculture local to urban residents. He also maintains that vertical farming requires fewer pesticides, herbicides and fungicides because crops will be grown indoors.

Is the Idea Ripe?

Vertical farming relies on hydroponics. Hydroponics has been used for decades to grow all manner of produce—ranging from tubers like potatoes to orchard crops—as a means to limit soil erosion. No soil is involved for plants, as they receive their nutrients via sprays of water containing necessary minerals normally absorbed from the soil. The plants themselves are suspended in a medium like gravel, wool or volcanic glass. The water is often recycled rather than becoming agricultural runoff, meaning hydroponics can rely on less water overall than traditional farming with soil.

Existing greenhouse agriculture informs future plans for vertical farming. According to Gene Giacomelli, director of the Controlled Environment Agriculture Center at the University of Arizona in Tucson, greenhouses have been growing crops in controlled indoor environments for nearly one hundred years. Temperature, humidity, air flow and nutrient conditions can now grow nearly any kind of crop regardless of location or climate.

Giacomelli's team developed the South Pole Food Growth Chamber, which has been in operation in Antarctica since 2004. This 22-square-meter hydroponic facility feeds the 65-person science team at Amundsen-Scott South Pole Station at least one fresh salad daily during the winter months. Water is recycled, requiring only topping off once in a while, along with refreshing the minerals.

Bitter Fruit: Some Problems with Vertical Farming

Antarctica isn't a perfect model for vertical farming facilities. For one thing, artificial light is needed for a significant part of the year. Even with this significant expenditure of energy, however, the hydroponic facility is still more inexpensive and reliable for Antarctica than the limited wintertime supply flights. The tradeoff won't tip in favor of indoor farming everywhere—other places will need some artificial light, too, and it will prove to be a significant expense based on most current energy sources.

Light is the major impediment to vertical farming—enough so that some experts don't see it as viable presently. No matter where a hypothetical skyscraper farm is located, the plants nearest the windows will grow more quickly than the ones farther away. In fact, Peter Head, global leader of planning and sustainable development at British engineering firm Arup, says that light needs to be very tightly controlled for a uniform crop. Head has studied the idea of vertical farming and energy consumption. He believes cheap, renewable energy will be needed for vertical farming to become viable. To make his point, he refers to single-story greenhouse Thanet, a privately owned British facility supplying 15% of British salad greens during the winter. Thanet operates its own mini-power station to supply its crops with fifteen hours of light per winter day, which Head sees as undermining the notion that vertical farming will reduce carbon emissions and save energy.

Researcher Ted Caplow, an environmental engineer and founder of New York Sun Works, maintains that even with solar energy, the idea of vertical farming may be impractical. His nonprofit firm operates The Science Barge, a floating hydroponic facility. The one-story greenhouse of the barge has little need for artificial lighting and is functional with wind turbines and solar panels for its limited energy consumption. Caplow used his experience with the Science Barge to devise a rule of thumb for solar energy and greenhouse space: he says that for each square foot of growing space, twenty square feet of solar panels need to be deployed. Once crops are stacked into floors for vertical farming, this ratio clearly presents problems, even without factoring in artificial lighting.

Vertical-farming firm Valcent has developed a rail system to try to combat the problem of light distribution. However, this organization uses single-story greenhouses, so even though trays of plants are stacked on the rotating rail system, ambient light comes from above and all sides. Caplow maintains that this system wouldn't solve the whole problem for multiple floors of crops.

Caplow maintains that vertical farming does have some merit, but he envisions it as "vertically integrated greenhouses." In other words, the idea is practical only if integrated into skyscrapers that also include office or retail space. In those cases, crops are grown around the exterior of the buildings, sandwiched between glass layers and rotated on a belt system. Not only does this plan solve the lighting problem, but it also provides some climate control in for the interior and a nicer view in many cases. However, the square footage available is nothing like that of a building fully dedicated to agriculture.

What's Bearing Fruit Now

Currently, urban rooftop farming and hydroponics feeds locally grown produce to some city dwellers. For example, Gotham Greens, a pioneering Brooklyn-based organization, harvests 100 tons of produce for restaurants and retailers around New York City. It has created more locations outside the United States, too. However, as of now, the business model only works if city dwellers are willing to pay a premium for locally grown, sustainably produced foods.