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A farm deep inside a Brooklyn warehouse may lead the way to large-scale urban agriculture

Aquaponics once seemed like a hobby could be the future for growing food in New York City

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CLOSED LOOP: Waste from tilapia in Jason Green's tanks fertilizes herbs, which then filter the water. Both the greens and the fish are sold to restaurants.

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Here's one way to grow food in an urban environment: Raise a school of tilapia in a tank. Filter out the nitrogen-rich waste, and let naturally occurring bacteria transform it from ammonia into nitrate. Run that naturally derived fertilizer beneath the roots of greens, herbs and peppers. Let the veggies flourish beneath LED lights. Harvest the vegetables. Later, harvest the fish. Cook and serve.

Known as aquaponics, this complicated but efficient ecosystem is the latest attempt at making agriculture commercially viable in New York City—even though it has a spotty history, a not-quite-proven track record and plenty of skeptics.

"We do aquaponics for the quality of produce it yields," said Jason Green, CEO and co-founder of Edenworks, an emerging commercial aquaponics company in East Williamsburg, Brooklyn, that recently secured a commitment to supply baby greens and microgreens to Whole Foods Market stores in New York City later this year. "Our innovation is that we can do aquaponics cost-effectively, scalably and repeatedly."

Though the premise of mimicking a natural system in a closed environment is ancient, Green says that new technologies including proprietary software, a complex plumbing system and cost-efficient LED lighting, plus a soaring demand for local food, will make fish-fed farms viable on a large scale, even in inner cities. A 2010 report from the New York City Council cited \$600 million in unmet demand for regionally grown produce.

"Consumers are very interested in knowing the provenance of their food, and companies are responding to that by setting up systems to produce food in cities," explained Nevin Cohen, an associate professor of urban food policy at the CUNY School of Public Health.

Brian Mansour, who runs a 20-year-old aquaponics greenhouse at Cabbage Hill Farm in Mount Kisco, in Westchester County, says the economics of farming in the city will eventually be made to work. "It's just a matter of time before somebody with enough money and the right crew will get together the right model that will work," he said.



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Aquaponics company Edenworks is looking for new space to produce 50,000 pounds of fish each year

fish food is not always available than it does with the cost of getting products certified organic, Green said.

Green is now looking for a space with 8,000 to 10,000 square feet where Edenworks could harvest more than 120,000 pounds of baby greens and 50,000 pounds of fish each year. He expects to pay from \$10 to \$15 a square foot for the space and predicts an operating profit in the first year. The modular design means Edenworks can build the new farm in three months.

Indoor farming gives Edenworks an edge over Brooklyn's oldest aquaponics venture, OKO Farms, an outdoor, seasonal operation in Bushwick, founded with the help of the now-defunct Brooklyn Economic Development Corp. to supply the neighboring Moore Street Market. Buyers include Roberta's, the Bushwick brick-oven pizza joint, which purchases 10 to 15 pounds of basil a week in season. "We're not making a profit yet," said Yemi Amu, an OKO co-founder. "But we are on the way there."

OKO has also launched an aquaponics school and is expanding to a second, indoor area where Amu and her partner will grow food for the Bedford-Stuyvesant food pantry.

VertiCulture, a Brooklyn fish-and-farm operation that opened in 2012, says it has 30% operating margins, thanks to the density of its arrangements and willingness to lease less-desirable real estate. Last fall, the company opened a 450-square-foot indoor "vertical pond" on the roof of the former Pfizer pharmaceutical factory in Bushwick, now a home to many startup companies. "We're profitable in the first quarter and running out of product," said Miles Crettien, a co-founder, who said he and his partners are not yet taking salaries. "We're turning people away."

Crettien and his three partners now harvest 40 pounds a week of four highly sought-after products: basil (Thai and Genovese), spearmint and arugula. They sell to food markets including Foragers, Brooklyn Kitchen and the Bushwick Food Co-op, and to FreshDirect's hip offshoot FoodKick and Maple, a meal-delivery startup. "We find [their basil] to be incredibly fresh and more flavorful than traditionally grown basil," said Soa Davies, executive chef at Maple.

Demand, he says, is not an issue: "There are more restaurants than you can imagine, and everyone wants fresh," he said. He has no shortage of buyers for either vegetables or fish, especially in the winter, when regional outdoor farms can't harvest.

At Edenworks, the Whole Foods agreement will let Green expand from a small warehouse in East Williamsburg, where his team has spent 18 months and \$1.3 million in venture capital proving the concept of its modular farm, nurturing 50 pounds of tilapia and floating seed trays of chard, arugula and basil.

The farm's products are chemical-free, even if they are not labeled organic. That has less to do with the fact that organic

Different plants have different “lighting recipes,” but beneath LEDs that stay on about 18 hours a day and well nourished by nutrient-rich water, the hothouse produce acquires the same flavors as if it were grown on a Tuscan hillside, Edenworks’ Green explained.

Nothing fresher

Freshness augments flavor too. “We’re harvesting the same day greens are going out,” said Crettien. “People are getting the freshest product on the market, directly from our farm.” The demand and profitability have driven VertiCulture to plan to increase crop size 12-fold in the next six months, to 600 pounds a week of greens and herbs. For that, they are seeking a 2,000- to 6,000-square-foot facility.

VertiCulture has grown sales this year at a rate of 20% per month and is seeking \$500,000 to \$1.5 million to build a 2,500- to 5,000-square-foot farm. To woo investors, Crettien and his team are aiming to secure three new customers a month. He hopes to have 100,000 square feet of growing space in the city and open 20 farms across the U.S. in the next five years.

Aquaponic greens take anywhere from a week to seven weeks from seed to harvest. That quick turnaround appeals to chefs who want specific mixes of greens or herbs for their seasonal menus. Every week, an Edenworks employee hops on the L train with clamshells of a custom microgreen mix, bound for Gramercy’s Adalya restaurant. “Because I was the first customer, I had the ability to ask him to grow things for me. Now a year later, he’s offering me choices—all these different kinds of microgreens,” said Derek Miles, the executive chef.



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The water flows under rafts to grow plants, and circulates back to the fish.



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Green says that new technologies including complex plumbing systems and cost-efficient LED lighting will make fish-fed farms viable on a large scale

Complete control of the growing

environment—temperature, lighting and the plants’ nutrient intake—means aquaponic farms can easily satisfy New York’s famously demanding chefs and consumers and create a predictable business model, a key to their financial success. Edenworks’ engineers monitor the water chemistry, leaving farming as little more than “a to-do list: This needs to be harvested today; this needs to get seeded today,” Green said.

Still, as much as he likes the produce, Adalya’s Miles, like other chefs and buyers, is price-sensitive. “If you want to be a chef that buys more environmentally conscious products, the price sometimes skyrockets.” His location near the Union Square Greenmarket means Edenworks does have competition.

At retail, a 5-ounce clamshell of Edenworks baby greens sells for \$3.99 to \$4.49. Organic Baby Lettuce Mix

from Earthbound Farms in California costs \$3.99 at FreshDirect while packages of local Gotham Greens full-sized lettuce run about \$4.40 for the same amount. Crettien says VertiCulture spends less than \$1 to grow enough basil for its 1-ounce package, which retails for \$3.99 on FoodKick.

In and out of cities, “small farms struggle with making enough money to cover their costs,” said Carolyn Dimitri, director of the food studies doctoral program at New York University and a former research economist at the U.S. Department of Agriculture. Here, where land is expensive, “the only way to make enough money is to have a very expensive product,” which means you need “a body of customers willing to pay a high cost.” Many of the boroughs’ 900 farms and gardens grow on borrowed or subsidized acreage, she notes, making their business plans irrelevant as models.

A 2015 U.S. Department of Agriculture study on the business of aquaponics found promising margins for vegetables. “However, the fish portion of the aquaponics system was not profitable, with the production costs of tilapia less than market price in only one study, and either higher or essentially the same in the others,” the report stated.

“There aren’t too many success stories,” said Prof. Martin Schreibman, an aquaponics expert at Brooklyn College. “I see a common pattern: a lack of knowledge and not enough funding. There are great ideas. The thing is to make music to the words. I haven’t seen enough of that.”

Scaling fish farms

In New Windsor, in Orange County, N.Y., a \$13 million investment and several tax breaks failed to show that aquaponics is a sustainable way of farming; the 175,000-square-foot greenhouse is in bankruptcy, owing at least \$9.7 million to creditors and production of fish and greens has plummeted. The market for urban farmed fish is also unproven, though Crettien says he has interest in his tilapia from one local market but no commitment yet. Cabbage Hill’s Mansour said Asian and Mexican grocers want more than his greenhouse can supply.

Gotham Greens—which farms on the roof of the Whole Foods Market in Gowanus and in greenhouses in Greenpoint and Jamaica, has 95,000 square feet in New York City and has quadrupled revenue in four years—won’t say if it’s paid off its initial investment, but says its New York farms are profitable.

Profit may not be the only metric for the success of urban aquaponics, says NYU’s Dimitri.

“Everybody interested in urban agriculture is looking at how companies will be able to be profitable—and how they can have a triple bottom line, in that they also give back to the community by employing people in the neighborhoods where they’re located, and maybe not selling all product at high margins by also selling to more affordable distribution channels,” she said. Educating urbanites about food systems is another important ambition, she says.

“I’ve been skeptical that urban agriculture that requires a lot of capital investment can easily be profitable,” said CUNY’s Cohen. “But I hope that entrepreneurs can figure out a way to make it happen because there are environmental, social and economic benefits.”

Even with their long-term commercial viability not quite proven, the plants at the Edenworks warehouse are flourishing. Roots are thin, tangled and free from goop, all signs of health, while leaves look strong and green. Water flows from a 250-gallon fish tank where the tilapia swim. Their waste moves out through a grid of tubes. To extract the solid matter and purify the water for reuse, Green’s team has set up aerobic

breakdown processes, keeping the warehouse free of fishy smells. The fertilized water moves through the growing beds, where plants absorb the nutrients. The plants filter the water, which is circulated back to the fish tank to be reused by the fish.

Could this pleasant, though hardly pastoral, agricultural represent aquaponics' moment? Thanks to technology, demand and entrepreneurial ambition, that wouldn't surprise even the skeptics.

"If the business model works," Cohen said, "there is huge potential."



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