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The Vertical Farm: Growing crops in the city, without soil or natural light. [Ian Frazier](http://www.newyorker.com/contributors/ian-frazier)

 *Vertical farming can allow former cropland to go back to nature and reverse the plundering of the earth.Illustration by Bruce McCall*

No. 212 Rome Street, in Newark, New Jersey, used to be the address of Grammer, Dempsey & Hudson, a steel-supply company. It was like a lumberyard for steel, which it bought in bulk from distant mills and distributed in smaller amounts, mostly to customers within a hundred-mile radius of Newark. It sold off its assets in 2008 and later shut down. In 2015, a new indoor-agriculture company called AeroFarms leased the property. It had the rusting corrugated-steel exterior torn down and a new building erected on the old frame. Then it filled nearly seventy thousand square feet of floor space with what is called a vertical farm. The building’s ceiling allowed for grow tables to be stacked twelve layers tall, to a height of thirty-six feet, in rows eighty feet long. The vertical farm grows kale, bok choi, watercress, arugula, red-leaf lettuce, mizuna, and other baby salad greens.

Grammer, Dempsey & Hudson was founded in 1929. Its workers were members of the Teamsters Union, whose stance could be aggressive. Once, somebody fired shots into the company’s office, but didn’t hit anyone. Despite the union, the company and its employees got along amicably, and many of them worked there all their lives. Men moved steel plate and I-beams with cranes that ran on tracks in the floor. Trucks pulled up to the loading bays and loaded or unloaded, coming and going through the streets of Newark, past the scrap-metal yards and chemical plants and breweries. In an average year, Grammer, Dempsey & Hudson shipped about twenty thousand tons of steel. When the vertical farm is in full operation, as it expects to be soon, it hopes to ship, annually, more than a thousand tons of greens.

Ingrid Williams, AeroFarms’ director of human resources, lives in Orange but knows Newark well. She has degrees in labor studies and sociology from Rutgers, and she visited many of the city’s public-housing apartment buildings in her previous job as a social-services coördinator. She is a slim, widely smiling woman with shoulder-length dreads who dresses in Michelle Obama blues, blacks, and whites. For a while, she had her own show, “The Wow Mom Show,” on local-access TV. Through it she met many people, including a woman who is a financial expert and helps local residents with their budgets. The two became friends, and last year when this woman was giving a speech at a Newark nonprofit Williams showed up to support her.

One of the other speakers that day was David Rosenberg, the C.E.O. and co-founder of AeroFarms. “A light went on in my head when I heard AeroFarms,” Williams told me. “There’s an AeroFarms mini-farm growing salad greens in the cafeteria of my daughter’s school, Philip’s Academy Charter School, on Central Avenue. I volunteer there all the time as part of parents’ stewardship, and I know the kids love growing their own lettuce for the salad bar.” After the speeches, she stayed to congratulate her friend and also introduced herself to Rosenberg. He asked her if she was looking for a job. She started as H.R. director at AeroFarms nine days later.

The mini-farm in the cafeteria at Philip’s Academy is a significant piece of technology. In fact, it is a key to the story, and it figures in the larger picture of vertical farming worldwide and of indoor agriculture in general. If the current movement to grow more food locally, in urban settings, and by high-tech indoor methods follows the path that some predict for it, the mini-farm in the school cafeteria may one day have its own historical plaque.

The mini-farm’s inventor, Ed Harwood, of Ithaca, New York, sold it to the school in 2010. Harwood is a sixty-six-year-old man of medium stature who speaks with the kind of rural accent that sometimes drops the last letters of words. He has been an associate professor at Cornell’s famous school of agriculture, and he began his career as an inventor by coming up with revolutionary improvements in the computer management of dairy cows, an animal he loves. His joyous enthusiasm for what he does has an almost messianic quality.

After spending part of his youth and young adulthood working on his uncle’s dairy farm, he got degrees in microbiology, animal science, dairy science, and artificial intelligence, and applied his knowledge to the dairy industry. One of the first inventions he worked on was a method to determine when a cow is in estrus. Research showed that cows move around more when they’re ready to breed. Harwood helped develop a cow ankle bracelet that transmitted data on how active the cow was each day; the farmer could then consult the data on his computer and know when it was time for the artificial inseminator. To check the accuracy of the bracelet, Harwood spent days walking around the pasture beside a cow with his hand on her back while he counted her steps. He enjoyed the companionship during this rather tedious exercise in ground-truthing and thinks the cow did, too.

He first became interested in growing crops indoors in the two-thousand-aughts. Around 2003, his notebooks and diaries began to converge on ideas about how he could raise crops without soil, sunlight, or large amounts of water. That last goal pointed toward aeroponic farming, which provides water and nutrients to plants by the spraying of a mist, like the freshening automatic sprays over the vegetables in a grocery’s produce department. Aeroponic farming uses about seventy per cent less water than hydroponic farming, which grows plants in water; hydroponic farming uses seventy per cent less water than regular farming. If crops can be raised without soil and with a much reduced weight of water, you can move their beds more easily and stack them high.

Harwood solved the problem of the crop-growing medium by substituting cloth for soil. He tried every type of cloth he could think of—“They got to know me well at the Jo-Ann Fabric store in Ithaca,” he said. Finally, he settled on an artificial fabric that he created himself out of fibres from recycled plastic water bottles, and he patented it. The fabric is a thin white fleece that holds the seeds as they germinate, then keeps the plants upright as they mature. The roots extend below the cloth, where they are available to the water-and-nutrients spray.

Devising a nozzle for the aeroponic sprayer proved a tougher problem. The knock on aeroponics had always been that the nozzles clogged. How he solved this Harwood won’t say. He has no patent for his new nozzle. “It’s more of a stream than a spray,” he said, “but we’re keeping the design proprietary. I have no fear of anyone copying it. You could look at it all day and never figure out how it works.”

He rented an empty canoe factory in Ithaca and set up a two-level grow tower a hundred feet long and five feet wide to employ his new discoveries, along with a light system that eventually consisted of L.E.D. lights modified to his needs. He had decided to grow commercial crops and chose baby salad greens. “My ‘Aha’ moment came when I was in the Wegmans supermarket in Ithaca,” he said. “My engineer, Travis Martin, and I looked at the greens for sale and saw that a pound of lettuce cost one dollar, while a pound of baby greens cost eight dollars. That was enough of a premium that we figured I could make my system profitable with baby greens, so I started a company I called GreatVeggies, and soon I was selling baby greens in several supermarkets in Ithaca.”

When that didn’t bring in enough money, he shut the company down. His financial situation, never robust, then took an upturn when an investor offered funding on the condition that he concentrate on selling the grow towers themselves, rather than the greens. Switching to that business model, Harwood formed a new company called Aero Farm Systems. He leased a number of his grow towers and sold a few. One of them went to Jeddah, Saudi Arabia, and he has no idea what happened to it. Another went to Philip’s Academy, where it’s the mini-farm in the cafeteria. The new company did not earn much, either, but he kept it going in a smaller part of the canoe factory.

The term “vertical farming” has not been around long. It refers to a method of growing crops, usually without soil or natural light, in beds stacked vertically inside a controlled-environment building. The credit for coining the term seems to belong to Dickson D. Despommier, Ph.D., a professor (now emeritus) of parasitology and environmental science at Columbia University Medical School and the author of “The Vertical Farm: Feeding the World in the 21st Century.”

Hearing that Despommier would be addressing an audience of high-school science teachers at Columbia on a recent morning, I arranged to sit in. During the question period, one of the teachers asked a basic question that had also been puzzling me: What are the plants in a soil-free farm made of? Aren’t plants mostly the soil that they grew in? Despommier explained that plants consist of water, mineral nutrients like potassium and magnesium taken from the soil (or, in the case of a vertical farm, from the nutrients added to the water their roots are sprayed with), and carbon, an element plants get from the CO2 in the air and then convert by photosynthesis into sucrose, which feeds the plant, and cellulose, which provides its structure.

In other words, plants create themselves partly out of thin air. Salad greens are about ninety per cent water. About half of the remaining ten per cent is carbon. If AeroFarms’ vertical farm grows a thousand tons of greens a year, about fifty tons of that will be carbon taken from the air.

Despommier lives in Fort Lee, New Jersey, and not long after his lecture I visited him at his apartment, in a high-rise with a skyline view of New York. He is a cheerful, demonstrative man, seventy-six years old, with a short gray beard and a mobile face. The concept of vertical farming came from a class he taught in medical ecology, he said. “It was in 2000, and the students that year were bored with what I was teaching, so I asked them a question: ‘What will the world be like in 2050?’ and a followup, ‘What would you *like* the world to be like in 2050?’ They thought about this and decided that by 2050 the planet will be really crowded, with eight or nine billion people, and they wanted New York City to be able to feed its population entirely on crops grown within its own geographic limit.

“So they turned to the idea of rooftop gardening,” he continued. “They measured every square foot of rooftop space in the city—I admired how they went to the map room of the public library on Forty-second Street and found aerial surveys and got their rulers out—and then they calculated what the city’s population will be in 2050, and the amount of calories that many people will need, and what kind of crops can best provide those calories, and how much space will be necessary to grow those crops. Finally, they determined that by farming every square foot of rooftop space in the city you could provide enough calories to feed only about two per cent of the 2050 population of New York. They were terribly disappointed by this result.”

At the time, Despommier’s wife, Marlene, who is a hospital administrator, was working in midtown Manhattan. As the couple drove back and forth along the West Side Highway, Despommier considered the light-filled glass-and-steel structures, and that got him thinking about the thousands of abandoned buildings throughout the city. He began to wonder why plants couldn’t live on multiple levels, as human beings do. For his next year’s class he carried over the previous year’s project, and this time had the students calculate what kind of structure a multilevel urban farm would need and how many people you could feed that way.

Despommier taught the class for nine more years, always asking his students to build on what previous classes had done. He began using the term “vertical farming” in the second year. For methods of indoor agriculture, he referred to technology pioneered by NASA and to the work that a scientist named Richard Stoner did decades ago on how to grow crops in non-Earth environments. By the class’s final year, Despommier and his students had determined that a complex of two hundred buildings, each twenty stories high and measuring eighty feet by fifty feet at its base, situated in some wide-open outlying spot—say, Floyd Bennett Field, the airport-turned-park on Jamaica Bay in Brooklyn—could grow enough vegetables and rice to feed everybody who will be living in New York City in the year 2050. These vertical farms could also provide medicinal plants, and all the herbs and spices required for five different traditional cuisines.

The possibilities that opened up put stars in his eyes. Agricultural runoff is the main cause of pollution in the oceans; vertical farms produce no runoff. Outdoor farming consumes seventy per cent of the planet’s freshwater; a vertical farm uses only a small amount of water compared with a regular farm. All over the world, croplands have been degraded or are disappearing. Vertical farming can allow former cropland to go back to nature and reverse the plundering of the earth. Despommier began to give talks and get noticed. He became the original vertical-farming proselytizer. Maybe the world’s mood was somehow moving in that direction, because ideas that he suggested other people soon created in reality.

“When my book came out, in 2010, there were no functioning vertical farms that I was aware of,” Despommier said. “By the time I published a revised edition, in 2011, vertical farms had been built in England, Holland, Japan, and Korea. Two more were in the planning stages in the U.S. I gave a talk in Korea in 2009, and they invited me back two years later. Fifty reporters were waiting for me. My hosts led me to a new building, where they had ‘Welcome Dr. Despommier’ in neon lights. I saw that, and I cried! The ideas that I had described in my ’09 talk they had used as the basis for building a prototype vertical farm, and here it was. When I’m lying in my coffin and they pull back the lid, the smile on my face will be from that day in Korea.”

Today in the U.S., vertical farms of various designs and sizes exist in Seattle, Detroit, Houston, Brooklyn, Queens, and near Chicago, among other places. AeroFarms is one of the largest. Usually the main crop is baby salad greens, whose premium price, as Ed Harwood realized, makes the enterprise attractive. The willingness of a certain kind of customer to pay a lot for salad justifies the investment, and after the greens get the business up and running its technology will be adapted for other crops, eventually feeding the world or a major fraction of it. That is the vision.

AeroFarms occupies three other buildings in Newark aside from the main vertical farm, on Rome Street. At 400 Ferry Street, it has a thirty-thousand-square-foot space whose most recent previous use was as a paintball and laser-tag entertainment center called Inferno Limits. The graffiti-type spray-painted murals and stylized paintball splatters of that incarnation still cover the walls. AeroFarms’ headquarters—sometimes referred to as its “world headquarters”—are in this building, some of which is taken up by a multiple-row, eight-level vertical farm that glows and hums. Technicians in white coats who wear white sanitary mobcaps on their heads walk around quietly. Some of these workers are young guys who also have mobcaps on their beards. The salad greens, when you put on coat and mobcap yourself and get close enough to peer into the trays, stand in orderly ranks by the thousands, whole vast armies of little watercresses, arugulas, and kales waiting to be harvested and sold. For more than a year, all the company’s commercial greens came from this vertical farm.

Nobody in the building appears to have an actual office. Employees are distributed in more or less open spaces here and there. In a dim corner of the area with the vertical farm, where the fresh, florist-shop aroma of chlorophyll is strong, young graduates of prestigious colleges confab around laptop screens that show photos of currently germinating seeds and growing leaves. Folding tables burgeon with cables, clipboards, and fast-food impedimenta. David Rosenberg, the C.E.O., who hired Ingrid Williams last year, is the boss. This distinction is hard to notice, because he looks more or less like anybody else.

I first met Rosenberg at an international conference on indoor agriculture held at a theatre in Manhattan. He wore dark jeans, a blue-and-white plaid shirt with the AeroFarms logo on the breast pocket, and running shoes. In past years, he used to fence competitively and win championships. He is forty-four, tall, and still fit, with close-shaved black hair and dark, soulful eyes. The quietness and patience with which he speaks can be disconcerting. He grew up in the Bronx, went to U.N.C. at Chapel Hill, and got an M.B.A. from Columbia in 2002. AeroFarms is not his first company. When his grandfather Michael Rhodes, a chemist, died, in 2002, a relative told Rosenberg about a molecule that his grandfather had created that could be used to make a weatherizing treatment for concrete. Rosenberg used his grandfather’s invention to start a business called Hycrete, which he later sold, though not for a sum so great that he has chosen to fund AeroFarms himself. In recent years, his new start-up has raised more than fifty million dollars in investment, about twice as much as has any other vertical farm, or indoor farm of any kind, in the U.S.



Top of Form

Bottom of Form

After Hycrete, he wanted to create a for-profit company that would do good for the environment and for society. With his fellow business-school alumnus and fellow-fencer Marc Oshima, he set about researching the latest indoor agricultural technology. When they learned about the work of Ed Harwood, they immediately got in touch with him. “David and Marc called me, and they kept calling back and asking better and better questions,” Harwood remembered. “They said they wanted their first farm and their world headquarters to be in Newark, and I told them, ‘I’ve got a grow tower in a school cafeteria in Newark!’ That’s when I knew this was going to work out.”

Rosenberg and Oshima had set up an indoor-agriculture company called Just Greens, which existed primarily in name. Harwood had the trademark on the name Aero Farm Systems. They proposed to him that the two companies merge and do business under the name of AeroFarms. Rosenberg would be the chief executive officer, Oshima the chief marketing officer, and Harwood the chief science officer. Like the original Aero Farms Systems, this company would base itself on Harwood’s patented cloth for growing the plants and on his nozzle for watering and feeding them. It would build the vertical-farm systems but not sell them, grow baby greens commercially, and scale the operation up gigantically. This change in fortunes left Harwood thunderstruck. “I couldn’t believe it,” he said. “How many inventors have inventions sitting around, waiting for a break, and then something like this happens?”

Most of America’s baby greens are grown in irrigated fields in the Salinas Valley, in California. During the winter months, some production moves to similar fields in Arizona or goes even farther south, into Mexico. If you look at the shelves of baby greens in a store, you may find plastic clamshells holding five ounces of greens for $3.99 (organicgirl, from Salinas), or for $3.29 (Earthbound Farm, from near Salinas), or for $2.99 (Fresh Attitude, from Quebec and Florida). Harwood’s magic number of eight dollars a pound would be on the cheap side today. Four dollars for five ounces comes to about thirteen dollars a pound.

AeroFarms supplies greens to the dining rooms at the *Times*, Goldman Sachs, and several other corporate accounts in New York. At the moment, the greens can be purchased retail only at two ShopRite supermarkets, one on Springfield Avenue in Newark and the other on Broad Street in Bloomfield. The AeroFarms clamshell package (clear plastic, No. 1 recyclable) appears to be the same size as its competition’s but it holds slightly less—4.5 ounces instead of five. It is priced at the highest end, at $3.99. The company plans to have its greens on the shelves soon at Whole Foods stores and Kings, also in the local area. Greens that come from California ride in trucks for days. The driving time from AeroFarms’ farm to the Newark ShopRite is about eleven minutes. The company’s bigger plan is to put similar vertical farms in metro areas all over the country and eventually around the world, so that its distribution will always be local, thereby saving transportation costs and fuel and riding the enthusiasm for the locally grown.

At the Bloomfield ShopRite, I watched a woman pick up a clamshell of AeroFarms arugula, look at it, and put it back. Then she picked up a clamshell of Fresh Attitude arugula and dropped it in her cart. I asked her if she knew that AeroFarms was grown in Newark. She said, “I thought it was only distributed from Newark.” I told her the arugula was indeed Newark-grown and explained about the vertical farm. She put the out-of-state arugula back, picked up the Newark arugula, and thanked me for telling her. I think AeroFarms does not play up Newark enough on the packaging. They should call their product Newark Greens.

The reason they don’t is probably the obvious one—the negative ideas that salad buyers may have about Newark, its poverty and history of environmental disaster, including the presence of Superfund toxic-waste sites contaminated by dioxins and pesticides. That’s not the aura you want for a healthy-greens company. AeroFarms chose Newark because of its convenient location and the relative cheapness of its real estate. City and state development agencies encouraged the decision, and the company has hired about sixty blue-collar workers from Newark, some of them from a program for past offenders. At least geographically, the company so far is exclusively a Newark production.

But in another sense it could be anywhere. The technology it uses derives partly from systems designed to grow crops on the moon. The interior space is its own sealed-off world; nothing inside the vertical-farm buildings is uncontrolled. Countless algorithm-driven computer commands combine to induce the greens to grow, night and day, so that a crop can go from seed to shoot to harvest in eighteen days. Every known influence on the plant’s wellbeing is measured, adjusted, remeasured. Tens of thousands of sensing devices monitor what’s going on. The ambient air is Newark’s, but filtered, ventilated, heated, and cooled. Like all air today, it has an average CO2 content of about four hundred parts per million (we exceeded the three-fifty-p.p.m. threshold a while ago), but an even higher content is better for the plants, so tanks of CO2 enrich the concentration inside the building to a thousand p.p.m.

The L.E.D. grow lights are in plastic tubing above each level of the grow tower. Their radiance has been stripped of the heat-producing part of the spectrum, the most expensive part of it from an energy point of view. The plants don’t need it, preferring cooler reds and blues. In row after row, the L.E.D.s shining these colors call to mind strings of Christmas lights. At different growth stages, the plants require light in different intensities, and algorithms controlling the L.E.D. arrays adjust for that.

In short, each plant grows at the pinnacle of a trembling heap of tightly focussed and hypersensitive data. The temperature, humidity, and CO2 content of the air; the nutrient solution, pH, and electro-conductivity of the water; the plant growth rate, the shape and size and complexion of the leaves—all these factors and many others are tracked on a second-by-second basis. AeroFarms’ micro-, macro-, and molecular biologists and other plant scientists overseeing the operation receive alerts on their phones if anything goes awry. A few even have phone apps through which they can adjust the functioning of the vertical farm remotely.

Though many of the hundred-plus employees seem to be diffused throughout the enterprise and most vividly present in cyberspace, everybody gathers sometimes in the headquarters building for a buffet-style lunch, at which Rosenberg makes a short speech. Talking quietly, he repeats a theme: “To succeed, we need to be the best at four things. We need to be the best at plant biology, the best at maintaining our plants’ environment, the best at running our operational system, and the best at getting the farm to function well mechanically. We have to be the best total farmers. And to do all this we need the best data. If the data is not current and completely reliable, we will fail. We must always keep paying close attention to the data.”

Ed Harwood’s original prototype mini-farm, the one he sold to Philip’s Academy in 2010, still produces crops six or seven times every school year. The invention sits in a corner of the cafeteria by the round lunch tables and the molded black plastic cafeteria chairs, an improbable-looking teaching tool. Examining it, you feel a mystified wonder, and perhaps a slight misgiving about the inventor’s soundness of mind, remembering what happened to Wile E. Coyote. For concentrated ingenuity and handcrafted uniqueness, its closest simile, I think, is the Wright brothers’ first biplane, the Flyer, now on display in the National Air and Space Museum, in Washington. Like the Flyer, and like many other great inventions, Harwood’s prototype is also an objet d’art.

Its dimensions are five feet wide by twelve feet long by six and a half feet high. Essentially, it consists of two horizontal trays of thick plastic, both about ten inches deep, one above the other, suspended in a strong but minimal framework of aluminum. Below the trays, at floor level, a plastic tank holds two hundred and fifty gallons of water. Frames like those used for window screens fit on top of the plastic trays. Each frame holds a rectangle of Harwood’s grow cloth, about two and a half feet by five feet in size. The cloth is attached to the frame by snaps. On small pipes running along the inside bottom of the tray, Harwood’s special nozzles emit a constant, sputtering spray of water at a downward angle. The spray hits the bottom of the tray and bounces up, and some of it becomes the mist that nourishes the roots growing through the cloths. Eventually, most of the water drains down and returns to the tank to be reused.

Seeds speckle the white surface of the cloth. The L.E.D. lights above the trays shine on the seeds. They germinate, and soon the roots descend. Seedlings grow. In about three weeks, the plants are ready for harvesting. The trays are taken out and the leaves are cut off and given to the cafeteria staff, who put them in the salad bar. The cloths are scraped of residues, which are composted for the school’s rooftop garden, and then the cloths go into the washing machine to be laundered for reseeding.

Throughout the mini-farm, PVC pipes and wires run here and there, connecting to clamps and switches. The pumps hum, the water gurgles, and the whole thing makes the sound of a courtyard fountain.

The teacher who keeps all this machinery in good order is Catkin Flowers. That is her real given name. A tall auburn-haired woman in her forties, she starts her science students working with the farm when they’re in kindergarten. “We use the farm to teach chemistry, math, biology,” she explained to me one morning between classes. “The students learn with it all the way through eighth grade. I think the farm is the reason our science scores are so competitive in the state. We get the kids involved in running the grow cycles and then solving the problems that inevitably come up. That’s how kids really learn, not from sitting back and watching the grownups do everything.”

“We’re also teaching food literacy,” put in Frank Mentesana, the director of EcoSpaces, the school’s environmental-science program, who joined us. “Some of our kids have never seen vegetables growing. They may live in a part of the city that’s a food desert, and their families get food at McDonald’s or at bodegas. They may never have seen fresh greens in a store.”

“Kids love to grow things,” Flowers said. “It teaches them about nutrients, the minerals we put in the water, and why the water’s pH affects how the plants absorb them, and about the light spectrum, and how photosynthesis works. The kids monitor the same kind of data as AeroFarms does, but less of it, of course.”

“Ed Harwood is still a huge help,” Mentesana said. “If we have a problem with the farm that we can’t solve, Ed will make time to stop by and fix it.”

“When we’re ready to harvest, the kids can’t wait to eat what they’ve grown,” Flowers said. “They’ll start eating the plants while they’re harvesting, and we actually have to tell them to wait because these are for the salad bar. They want to find out how they taste. And they’re excited when the plants they’ve grown become part of a meal for the whole school. Because of this farm, our school’s consumption of leafy greens is probably not met by any other school in the country.”

On another morning, I stayed for lunch. First, Mentesana took me, along with Marion Nestle (not Nestlé; she’s no relation), the nutrition expert and N.Y.U. professor, on a tour of the school. A Clinton campaign e-mail released by WikiLeaks the day before had referred to harassment of Nestle by the beverage industry because of her book “Big Soda: Taking on the Soda Industry (and Winning),” and she was in a great mood, proud to have been mentioned. Robert Wallauer, the school’s young chef, introduced himself. He has worked for famous restaurants, but decided he could contribute more to the public good by running school kitchens. The entrée was a Chinese-style dish of pasta with chopped vegetables. I told him it was so delicious that if this were a restaurant I would come back and bring my friends.

Zara Hawkins, a fifth grader, stopped by our table. Her mother is Ingrid Williams, the H.R. director at AeroFarms. Zara has a quiet manner, and she sometimes looks thoughtfully into the near distance as she talks. She noted the greens we’d just been served, supplied by AeroFarms. “We eat a lot of this salad at home,” she said. “My mom brings the bags of lettuce from work. I didn’t use to like it, but now I do. I have the baby kales in omelettes, with cheese. You can also put them in smoothies. They are O.K. In fact, they can be pretty good.”

Wallauer got up and brought us back glasses of a kale-pineapple-and-yogurt smoothie whose color had the bright seaside green of a lime treat. “It takes a while for kids to start eating certain foods if they’re not used to them,” Wallauer said. “We made some of these smoothies yesterday, and we handed them out as dessert. One little girl took a sip and said it was pretty good. Then she took another and looked at me suspiciously and said, ‘Did you put salad in this?’ ”

A few weeks before the vertical farm at 212 Rome Street was to harvest its first official crop, I walked through the building with David Rosenberg. After the usual handwashing, putting on of mobcaps and coats, and wiping our feet on mats for disinfecting, we stepped into the high-ceilinged room where the vertical farm was humming away. If Harwood’s prototype at the school was the Wright brothers’ first biplane, this immense scaled-up elaboration of it was a spaceship in drydock.

I thought of the tenderness of the greens this device produces—a natural simplicity elicited mainly from water and air by high-tech artifice of the most complicated and concentrated kind. It seemed a long way to go for salad. But if it works, as it indeed appears to, who knows what might come of it when we’re nine billion humans on a baking, thirsting globe? Rosenberg and I stood looking at the vertical farm in silence. On his face was a mixture of pride and love; he might have been seven years old. “We are so far above everybody else in this technology,” he said, after a minute or two. “It will take years for the rest of the world to catch up to where we already are now.” ♦ Ian Frazier is a staff writer at *The New Yorker*. <http://www.newyorker.com/magazine/2017/01/09/the-vertical-farm>