CHAPTER 6

BACK WHEN THE STONE BARNS CENTER opened for business in the spring of 2004, the soils growing the vegetables for Blue Hill were already filled with life. That wasn't just luck. Ten years after I first read Eliot Coleman's advice on growing healthy plants, he was hired to consult on the center's creation. Eliot's charge was to identify the best land on the property for cultivating vegetables.

The first time he came to visit the site was on a crisp fall afternoon in 2002. As the daylight faded in the cold, slow burn of late November, Eliot seemed anxious. He had decided on a relatively flat, healthy field running the length of the property. But then we came to the bottom of another long field, sloping upward from the largest of the stone barns (Blue Hill's future dining room), where the dairy cows had been milked in the 1930s and '40s. Eliot stopped and scanned the six-acre expanse.

"The cows probably pastured here," he said softly, almost to himself. When I turned to look, Eliot had dropped his bag and started running. He traversed the old pasture, slaloming back and forth, dodging rocks and thistle, all along rotating his head to study the position of the waning sun. He ran past what would later become home to rows of tomatoes, cucumbers, fava beans, parsnips, and eventually the Eight Row Flint corn, until he arrived at the highest point, where he raised his finger to the sun. Then he was off again, to the northeast corner of the field, where he stopped, hands on hips, and scanned the land intently. Even in his early sixties (and still today), there

was something hopeful and blithe in his pursuit. Eliot is like a wild horse—curious, observant, sly, and energized by an intuitive connection to nature. I watched him in awe.

"Hey, fucking cool," he said on his return, his dirty blond hair gleaming in the dull light. His eyes were wide and nearly pulsating; he looked to be breathing through them. He had a fistful of soil, and he turned his hand up so I could have a look.

"Black enough for you?" he asked. "*This* is the field. Forget the other one. It's making me hungry just thinking about what you're going to grow here." I asked if he had changed his mind based on the field's position in relation to the sun.

"The sun? Oh, hell, no. I was looking at the sun because it's so damn beautiful right now." He squinted his eyes, admiring the last of it setting in the distance. "No, I wanted to make sure this had been pasture for the cows."

Eliot explained that the field closest to the milking barns was usually the one most grazed by the cows (why walk the cattle farther than necessary at 5 a.m.?) and therefore the most mineralized by manure. In this case, he was right. The field, we later confirmed, had once been grazed by the Rockefeller family's dairy cattle.

"I bet there's a deep layering of organic matter," Eliot said. "It's going to grow vigorous, absolutely delicious plants."

Having mapped out the land, Eliot was assigned his second task: help find a farmer. Here he had the good sense to consult Amigo Bob Cantisano, the legendary and widely influential sage of California organic agriculture. I first met Amigo at Laverstoke—he had been among Eliot's Fertile Dozen. Mutton-chopped and mustached, he has thick, silvery-black Rasta hair down his back, and he speaks through a spitball of chewing tobacco, making him look more Pancho Villa–like than plain old Bob-like. (Which may explain why he's simply called "Amigo"—the name his girlfriend gave him in high school.)

Amigo recommended Jack Algiere, a young farmer he had grown to admire after consulting with him on an organic olive farm. "I've worked with

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so many farmers over time, I can't remember one from the other," he told me, though I wondered if his years spent under the herbal influence might also account for the haziness. "Sometimes I'll work with a guy who could have been a rocket scientist if he had wanted—you know, they've really just got it going on up here," he said, drilling his index finger into the side of his skull. "Jack's one of those."

16.9

Jack turned out to be as gifted as Amigo Bob promised, and as curious as Eliot about how to grow great-tasting food.

One day, during an especially cold stretch of winter in 2006, a few years after Blue Hill at Stone Barns opened, Jack came running into the kitchen, smiling big. Jack has curly hair and—especially back when his beard was still full and flowing—the look of a man who works closely with nature. You might say (although he wouldn't) that he's sort of a cross between Paul Bunyan and a young Bob Dylan.

On this particular day, he held two big handfuls of bunched carrots, their green tops waving in the air like pom-poms. It's hard not to be taken by Jack's electric good cheer in moments like these—showing off a new variety, or a perfectly ripe vegetable. You'd think such displays would happen often in a kitchen that's connected to a working farm, but the truth is that we tend to ignore one another, the farmers and the cooks, precisely because we're so close. The morning harvest arrives, it gets organized in the receiving room and stored in the coolers, and by the end of dinner service it's gone.

"We're sort of like a marriage," Jack once said. "We need to do one of those date nights every week just so we can actually talk."

Jack placed the carrots on a cutting board and took a step back, allowing us to admire his work. The last time he'd displayed his wares like this, it was an exotic variety of ginger, and before that an "extra dwarf" bok choy that fit into my palm. But carrots? They were always growing—in the field during

the spring and summer and in the greenhouse most of the winter and spring. They were usually good carrots, sometimes exceptionally good, but did they deserve such swagger?

"Sixteen-point-nine, pal," he finally said. "Sixteen-point-freakin'-nine."

"Sixteen-point-nine?" I repeated, not understanding.

"Brix," Jack said, removing a small handheld refractometer from his pocket as evidence. Refractometers, which look like high-tech spyglasses, are popular tools for measuring the Brix, or amount of sugar present, in a fruit or vegetable. They've been used for years to verify levels of sweetness in grapes, helping winemakers determine ideal harvest times.

But Brix also indicates the presence of healthy oils and amino acids, proteins, and—this is key—minerals, those ingredients that Albrecht recognized were so critical for flavor. A 16.9 reading means the carrots were 16.9 percent sugar—and bursting with minerals. It's an extraordinarily high number, which Jack made sure I understood, even as the cooks, being cooks, drifted away to get back to work.

"Off-the-charts high," Jack said, watching me take a bite. He wasn't kidding. The variety, mokum, had been shown to reach a Brix of 12, a fact Jack discovered before his visit to the kitchen. So the astonishingly delicious mokum carrots I tasted that day were, in fact, off the charts.

ON JACK ALGIERE

Jack grew up on a farm tucked away at the end of a mile-long driveway along the Pawcatuck River in southern Rhode Island. In the mornings, his mother would open the kitchen door to shoo her son into the forest and fields, not to return until dinnertime. His carefree explorations gave him a passion for nature that the biologist E. O. Wilson, who enjoyed the same kind of childhood, calls "biophilia"—an "innate tendency to focus on life and lifelike processes."

By the time Jack graduated from high school, he had decided to farm for

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a living. That summer, he worked in a large greenhouse close to home, growing vegetables, shrubs, trees, and a variety of flowers, all started from tissue cultures rather than seed.

"That's how greenhouses generally work," he explained to me. "You grow five thousand plants that are carbon copies of one another." Genetic uniformity like this—a super-monoculture, essentially—under a closed roof is extremely susceptible to plant disease, which is why organic farming in greenhouses is so rare.

Jack saw the failings of the system up close. "One morning I went to water the geraniums," he told me. "I noticed a tiny black spot on one of the stems, which means you're about to be in major doo-doo." The black spot was made by a type of mold. And because of the crop's uniformity, Jack knew that none of the plants would have a natural defense against it. By noon that day the black spots had covered all the stems.

Jack consulted with the farm's owner, Bud Smith. "Bud was traveling at the time, but he had me go to this closet where we kept the full arsenal of chemicals and load up the strongest fungicide they had. I remember he said: 'Jack, don't fuck with this stuff.' If Bud was saying that, this had to be toxic as all hell." Bud had him wear a special protective suit and instructed him to seal the openings with duct tape.

"I caught a glimpse of myself as I walked out to the greenhouse. Like a space monster," Jack said. And then he sprayed—four entire houses filled with geraniums. "By the time I had finished spraying the first half of that first house, I was weeping. And I wept again inside when we realized the chemical had failed," Jack said. "The geraniums that survived looked really weird and ended up going to a local cemetery's urns, if you can believe the irony. But the memory of spraying stayed with me. It's the closest I've felt to being in the middle of a battlefield during a totally senseless war. I walked out of there and said to myself, *I don't want to be doing this.* And do you know what? I never did it again."

He intended to quit but was torn by his respect for Bud's great talent as a

greenhouse grower. So Jack went to Bud's office to talk to him. "I walked in and saw Bud sitting at his desk, looking up at me," Jack said. "He knew. He absolutely knew what had happened. It was the first time I'd ever seen an adult look vulnerable. So instead of quitting, I blurted out, 'Isn't there another way?' I realized at that moment that Bud didn't want to be spraying chemicals—he hated it, actually, and so does every farmer farming conventionally. All Bud said was, 'What can I do? The customer wants geraniums, a lot of them, and they'll only pay so much.'"

Jack convinced Bud to let him take over a few of the greenhouses and convert them to organic. "I made a million and a half mistakes," he said, "but converting those greenhouses totally changed my life. Without the license to try—to see that it could really work, organically—I probably would have quit farming altogether."

Realizing he needed to learn more, Jack studied horticulture at the University of Rhode Island. During his second year of studies, he had another epiphany. "The departments, the professors—they were all there acting as enablers, keeping the chemical industry going because someone somewhere had determined it was worth keeping alive," he said. "It was as if I was in school to learn how better to kill the geraniums instead of how to prevent the fungus."

Then he discovered the library's collection of agriculture books, which included works by Sir Albert Howard and Rudolf Steiner. "I read them and it clicked," he said. "I mean, it all just came together. Steiner was crying out to farmers in the mid-1920s, basically saying, 'Don't be fooled by chemicals!' He really spoke to me, because that's exactly what I was trying to say to Bud: *Don't be fooled by all of this.* I didn't know enough at the time to know that I was right, but when I read Steiner I suddenly took on a kind of confidence I had never experienced before."

When Amigo Bob contacted him about the job at Stone Barns, Jack and his wife, Shannon, were happily farming someone else's land in Connecticut. He took the job mainly for the chance to bring together the ideas of Howard

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and Steiner on a farm of his own design, one that connected the soil to everything around it—the flora and fauna, as he likes to say, but also the culture of the place.

The project didn't start off well. "Literally just before Stone Barns is to open, on my first day of work, 9 a.m., I drive up to the gate at the entrance to the farm and I find myself behind a large herbicide-spraying truck," Jack told me. "Spray the Problems Away Inc. or something like that. We sit there, both of us waiting for the gate to open, and I'm thinking, *Who's this guy?* So I honk my horn and get out of the car. 'Excuse me,' I say to the guy. 'What are you doing here today?' He looks at me all confused and says, 'I'm here to spray,' just like that. I'm thinking, wait a second, this is supposed to be a freakin' organic farm, right? The gate opens and we both drive in, the chemical truck and me, and I'm banging the dashboard, screaming, '*This can't be fucking happening.*' I had just left a great job, moved with my wife to a place where we didn't know a soul, and the first minute of the first day on a farm I'm about to spend—oh, I don't know, the next forty years—is going to get showered with an herbicide.

"We pull up to the offices, and I tell the guy to hang out a second. There are like three hundred people running around in construction hats, but no one to deal with this. Finally I get to the head of the construction company and ask about the chemical guy with the big truck. He consults his work sheet for the day. Sure enough, right there on the schedule is a 9 a.m. appointment to spray Rodeo in the pond between the future greenhouse and the future outdoor vegetable field. Supposedly there was an outbreak of phragmites, an invasive grass, and since the Stone Barns Center hadn't officially formed yet, these construction guys were just doing what they needed to do. It was like I was walking into the Wild West.

"I said, forget it. This is going to be an organic farm. If the guy sprays this stuff, game over. The head of construction looks at me, sympathetic, even though he has absolutely no idea what Rodeo is or how toxic it could be for the farm, or even that I'm barely ten minutes into the first hour of the first

day of my new job. I got ready to send the chemical guy home when the construction head discovers that the Rodeo spray, and a whole schedule of spraying for the next month, had already been contracted for. Thirty-five thousand dollars. Done, papers signed. I left and called James [Ford, the founding executive director of the Center], and he and I hatched a plan right there. The chemical company could keep their money, but they wouldn't spray. And that's what happened: $35,000 to do essentially nothing. I keep thinking, even to this day, what if I had showed up late for work?"

SOIL AND FLAVOR

The 16.9 mokums lasted only a few services, but the small harvest left a big impression. Which is why, the following week, early on a frigid January morning, I stood with Jack in front of a row of future 16.9's incubating in the rich soil of the greenhouse. He had offered to explain to me in detail how the carrots had come to be so delicious.

The 23,000-square-foot greenhouse was calm and quiet, save for the soft hum of the overhead fans. Jack wore a look of pride as he surveyed the rich black soil that spanned the building. The soil came from the excavation of the Stone Barns parking lot, which partly explains Jack's fondness. After the construction crews unearthed the virgin soil, Jack rescued it from the dumpster. Then he created a recipe for the highest-quality compost, mixing it in to build up the soil's organic matter. He applies a wheelbarrow of his compost to every new row of vegetables.

I was familiar with the power of compost (what I understood of it) and impressed by the quality of Jack's personal blend. So I had a sense of how, after several years of building fertility, the soil could now nurture a carrot with a Brix of 16.9. But how exactly?

Jack pointed to the soil. "There's a war going on in there!"

"War" seemed a funny way to put it. The process had always struck me

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as extremely cooperative: Leaves and needles and grasses eventually die, forming a brown carpet of carbon on top of the soil. Herbivores (such as cows) and birds (chickens) periodically disturb the surface, allowing soil organisms (worms) to reach up and pull this organic material deeper into the dirt, where it—along with other material such as dead roots—is broken into nutrients available to the plants.

Jack went on to explain this war, which is when my understanding of the soil organisms' shared objective—the notion that everyone works together for the betterment of the soil community—became more complicated. There is a whole class system. First-level consumers (microbes), the most abundant and minuscule members of the community, break down large fragments of organic material into smaller residues; secondary consumers (protozoa, for example) feed on the primary consumers or their waste; and then third-level consumers (like centipedes, ants, and beetles) eat the secondaries. The more Jack explained it, the more it started to sound like a fraught, complex community. Organisms within each level may attack a fellow comrade (say, a fungi feeding on a nematode—or vice versa), or any of the tiny eaters can, and often do, turn on their own kind.

All of this subterranean life, Jack explained, is forced to interact—"cooperatively, yes, but also violently and relentlessly to maintain the living system."

To call this war may be a little extreme. When I ran Jack's analogy by soil scientist Fred Magdoff, he likened the process to a system of checks and balances. "To me there is real beauty in how it works," he said. "When there is sufficient and varied food for the organisms, they do what comes naturally, 'making a living' by feeding on the food sources that evolution provided. Sure organisms eat one another, but is that war? We eat carrots, but are we declaring war on carrots? What you have is a thriving, complex community of organisms."

Which is precisely what we want for better-tasting food. The result of all this activity—combat or cooperation, you choose—is that insoluble

molecules are broken down and rearranged into forms accessible to plants. It's a process analogous to coffee making. Imagine, a farmer once told me, the difference in taste between a cup of coffee dripped through whole beans and one dripped through beans that have been broken apart into micro-granules.

Some of these microscopic nutrients combine to form phytonutrients, chemical compounds that are the building blocks of taste. "Like let's say calcium," Jack said. "Taste doesn't come just from calcium—not directly, at least. It comes from a more complex molecule that gets eaten, taken apart, and put back together in a different way. The plant takes this, and all the other molecules, and catalyzes them into phytonutrients. Taste doesn't come from the elemental compounds. It comes from the synthesis."

Phytonutrients—like amino acids, esters, and flavonoids—are key to the flavor of the mokum carrot, or whatever vegetable, grain, or fruit you're growing, Jack said. He crouched low to the ground to smooth out an uneven patch of soil. "And, not unimportantly—actually, *most* importantly," he continued, "phytonutrients are vital to building the immune systems of plants. They are part of the building blocks for vigor."

When insecticides and fungicides are used, they usurp the plant's natural defenses, which means the plant produces fewer phytonutrients. Studies show that organic fruits and vegetables typically contain between 10 and 50 percent more antioxidants and other defense-related compounds than are found in conventional produce.

Some scientists suggest it's one of the reasons organic food tastes better than conventional food. As soil biologist Elaine Ingham explained to me, "Phytonutrients are the building blocks for all of the flavor compounds. A lot of those flavor compounds are quite complex, and it takes quite a bit of energy and requires quite a diversity of building blocks in order to make them. So you have to have a plant with really good nutrition for those flavors to be expressed. It's not all that simple to have something that tastes really good. It's a lot easier to get something that has sweetness to it, but those really subtle complex flavors? You really have to have a healthy plant to have that."

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I thought of Klaas and the velvetleaf—his soybean crop's resistance was not only a sign of healthy soil but a promise of great flavor as well.

"That's just it," Jack said when I mentioned Klaas's work. "The development of flavor, and the health of the plant, are the same freakin' thing. You don't get one without the other. If I treat the soil's microorganisms right, if they have everything they need to prosper, they'll do the work for me. At that point you just need to put it on the plate, basically."

As we left the greenhouse, Jack acknowledged that the precise mechanics of flavor creation are still mysterious. He realized this many years ago, after experimenting with brining olives. At first he chose distilled vinegar, which, when used as a brine, produced a predictable olive—delicious, but uniform in flavor. "Then I used a live vinegar," he said, "and after six months to a year, with all the fungi and bacteria in there, some olives would turn out sweet like fruit, some smoky, some had a roasted flavor almost. It was wild! The same thing is true for soil. You have different things going on, catalyzing new flavors, reaching the full potential and expression of the plant. It's the action that's important. But who really knows what the hell is going on in there?"

The admission took me by surprise, if only because Jack always seemed to know *exactly what was going on in there*. But eventually I realized he had it just right. I thought of Sir Albert Howard, who, writing in 1940, could not have named the full roster of microorganisms. Nor would he have known a phytonutrient if he saw one. Nor could he have described the chemistry behind well-composted soils—even though he was a chemist, and the father of compost. He didn't need to. I suppose that, like Jack, Howard was fine with not knowing. Where there is a bit of mystery, respect—even awe—fills the void.

A little ignorance keeps us from wrongly thinking it's possible to manipulate the conditions for every harvest. It's humbling to not know the *how*, and in the end it's probably a lot healthier. In the words of ecologist Frank Egler, "Nature is not more complex than we think, but more complex than we can think."

If a great-tasting carrot is tied to the abundance of soil organisms, a bad-tasting carrot comes from the absence of soil life. Which is the big distinction between organic and chemical agriculture. The nutrients in compost are part of a system of living things. They are constantly absorbed and rereleased as one organism feeds on another, so they're continuously available as plants need them. The supply to the plant comes in smaller quantities than it does with fertilizer, but it comes in a steady stream. It's slow release, versus one heavy shot of chemicals. The disparity is enormous.

To administer the heavy shot, soil is bypassed. Synthetic fertilizer, in soluble form, is fed directly to the plant's root. "It's a fast system," Jack said. "Whoosh! Water and nutrients are just flushing through. You can get your crops to bulk up and grow very quickly."

This is one of the reasons conventional salad lettuce—iceberg lettuce from the Salinas Valley of California, for example—often tastes of virtually nothing. It's almost all water, and the nitrates saturate the water, leaving no room for the uptake of minerals.

Thomas Harttung, another of the Fertile Dozen farmers at Laverstoke and founder of the largest organic farming group in Europe, has compared it to cooking: "Imagine a wonderfully balanced Italian main course full of herbs and other fresh ingredients. You then drop the salt bowl into it—rendering it totally inedible. The other taste notes 'die.'" Industrially produced grains, vegetables, and fruits taste of almost nothing because the nitrates have crowded out the minerals.

To bypass the network of living things is to deprive the plant's roots of the full periodic table of the elements the soil provides. But it also deprives the soil organisms of their food source. When Klaas said the number of organisms in his fistful of dirt was greater than the population of Penn Yan, he added, "That's a lot of community life to feed." He meant it as an obligation. "What kind of soil life are we going to promote in our fields, and

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what kind of flavor are we going to get in our mouths, if we feed soil life garbage?"

Why limit the hand that feeds you? As Eliot Coleman once said, "The idea that we could ever substitute a few soluble elements for a whole living system is like thinking an intravenous needle could administer a delicious meal."

A SUBTERRANEAN VIEW

Late one afternoon the following November, Jack finished his carrot tutorial by excavating a three-foot ditch in the vegetable field next to the fall crop of mokums. We climbed into the trench to examine a cross-sectioned wall of black dirt. It reminded me of the glass-enclosed ant farms I studied in seventh-grade biology. But in the dim light, this soil looked both exposed and secretive. Jack, my subterranean escort, pointed with a small stick to the exposed earth, hoping to illustrate once more how flavor starts in the soil.

"You should see this, because everyone talks about the chemistry of soil, or the biology," Jack said, running his hand along the wall, "but without the right physical structure, say goodbye to chemistry and biology. Nothing works."

The root systems created what appeared to be small highways and back roads, allowing organisms the freedom to move around. It brought to mind the interior of a well-made loaf of bread—moist, textured, and filled with irregular bubbles. The miles of white, wispy root hairs clenching the dirt in Jack's trench looked like the strands of gluten in bread that allow it to expand in the oven. Unhealthy soil, by comparison, resembles cake mix—dry and packed down, with no spaces for air to circulate or organisms to maneuver. (No wonder Klaas advocates for rotations of spelt; its large, deeply penetrating root systems create space for the community to thrive.)

Pointing again with the stick, Jack circled the narrow areas around the

roots, the rhizosphere. It's the soil's most competitive environment, where organisms thrive in densities up to one hundred times greater than in other parts of the soil. The roots, sensing nutrients in the area, drill into the soil to take advantage of the rich possibilities for nutrition. In healthy conditions, the mycorrhizal fungi and the root tissue literally bind together, forming an unbeatable partnership that allows the root to reach even deeper into the earth, extracting what the soil has to offer.

"You can look at plants that produce mycorrhizal fungi like you look at oil companies," Jack said. "These companies invest the heavy costs of searching for oil if they believe it's a region rich with resources. The roots work like that. It's an incentive economy." He said plants will spend as much as 30 percent of their energy to build these fungal root extensions in order to tap into the tiniest spaces in the soil and get the nutrients there.

It turns out that the mechanism is a prerequisite for great wine. I learned this from Randall Grahm, the iconoclastic winemaker of Bonny Doon Vineyard, in Santa Cruz, California. "Mycorrhizae are microbial demiurges—they bring minerals into the plants," he told me. "What does that taste like? Persistence. The best wines are powerfully persistent. You breathe out your nose and you taste the wine over again, or you leave the bottle open for a week and the wine still tastes alive. Persistence doesn't fade, and it doesn't oxidize. That's from the minerals."

Jack got his finger into a nook of soil to show where the minerals are retrieved. "Here's where they suck out the phosphorus, or the copper or zinc, and all that comes up into the root with some stored water from the soil." He shook his head. "Brilliant, right? But you see what I'm saying? It's not just chemistry or biology down here. It all works if the physical structure is welcoming to the organisms and the fungi. At the end of the day, the plant's just looking for a good dinner, but he's got to be able to get to the table."

Peeking my head out of the ditch, I saw the final minutes of golden light bathing the upper stretches of the vegetable field. I remembered the fall afternoon eight years earlier (nearly to the day, and the hour) when Eliot

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Coleman galloped back and forth across the land and sensed—correctly, as it turned out—a deep layer of organic matter below our feet.

"In a healthy system," Jack said, waving his hand to indicate all the vegetation above us, "everything you're looking at has a corresponding weight of roots and organisms belowground. *Everything.*"

A corresponding weight? It seemed almost impossible to imagine. As ecologist David Wolfe says, human beings are "subterranean-impaired." We're unable to see what's underneath us. It took a visit to the control room (and, as I stood in the ditch, a nematode's view of the underworld) to change how I looked at a landscape: what we see aboveground—the plants, trees, wildflowers, shrubs, and grasses—is mirrored by root systems belowground. I suddenly thought back to Wes Jackson's image of perennial wheat, with its iceberg-like proportions. It's not green and lush and filled with sunlight, nor does it inspire painters or poets or picnics, but nature's underworld is at least half of the story.

0.0: THE INDUSTRIAL CARROT

Back in the kitchen, Jack brought out his refractometer to test another batch of mokums. They scored well again, with Brix readings between 12 and 14. Someone pulled a case of stock carrots from the refrigerator. Grown in Mexico, these workaday carrots are large, uniform, and fast-growing, which makes them cheap fodder for vegetable and meat stocks.

I asked Jack if adding soluble nitrogen to his mokum carrots would make them grow faster. "No way. You'd just end up burning the shit out of everything," he said. "Adding Synthetic N is like adding a bomb—I mean, bombs *are* N, the same ingredient, so think what happens if you were to drop a bomb in the middle of a community of soil organisms."

"So let's say I'm a mycorrhizal fungus . . ."

"Kiss your ass goodbye," Jack said, chopping the air. "Gone, goodbye. N

is ammonia, as in *ammonia*. It's burning, like the stuff you wash your floors with, only it's double, triple that in strength. If you're fungi, you're hightailing it out of there."

The Mexican carrots were from a large organic farm, an example of what Michael Pollan calls "industrial organic" and Eliot Coleman once described as "shallow organic." Such farms eschew chemical fertilizers and pesticides and technically abide by organic regulations, but they use every opportunity to operate in the breach. They grow in monocultures, they look to treat symptoms instead of causes, and, to cut to the real offense, they don't feed the soil.

"Carrots like these are all grown in sandy soils," Jack told me. "It's sand, water, and fertilizers." Organic fertilizers are the tools of the shallow organic farmer's trade. Like chemical fertilizers, they are applied in a soluble form, feeding the plant but not the soil.

Jack squeezed the juice and read the refractometer. "Whoa," he said.

"What did you get?" His expression had me imagining the Mexican carrot registering 20.9.

He shook the refractometer, squeezed more juice, and stared at the monitor. "Holy cow . . . zero."

"Zero?"

"Zero point zero," he said, flashing me the screen. "There's no detectable sugar."

"I didn't know a zero-sugar carrot was possible," I said.

Jack was silent a moment, holding the carrot up to the light as if it were a lab experiment. "Neither did I."

He said the Brix discrepancy could be attributed to several factors. Mokums were bred for outstanding flavor, for one thing, giving them a hereditary leg up on the Mexican organic variety, which was likely conceived for high yields or better shelf life. So comparing the mokum with the Mexican vegetable wasn't actually comparing carrots with carrots. And then there's the mokum's stress response, in this case to the cold snap we were

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experiencing. Freezing temperatures kick-start a carrot into converting starches to sugars. This neat physiological trick raises the internal temperature and prevents ice crystallization, helping the carrot survive another day. The Mexican carrots, in contrast, hadn't lived a day under a balmy sixty degrees.

But none of these excuses could disguise the essential difference between the two carrots. Jack's carrots were satiated with nutrients; the others were starved. By afternoon's end on this chilly fall day with Jack, I'd come to another paradigm-shifting realization about soil. Until then, I had held on to a remarkably simple misconception about conventional agriculture: that chemical farming kills soil by poisoning it (which it can) and that ingesting chemicals is unappetizing and harmful (which it probably is). But both miss the larger point if you're after a 16.9 carrot. Chemical farming—and bad organic farming—actually kills soil by starving its complex and riotous community of anything good to eat.

"To be well fed is to be healthy," Albrecht said. And he meant more than eating fruits and vegetables. He wanted to know what the fruits and vegetables were eating as well. (As Michael Pollan observed, you aren't just what you eat. "You are what you eat eats, too.")

Albrecht would not have been surprised by a 0.0 carrot, since he warned that soil microbes "dine at the first table" and should therefore have their plates filled with minerals. If not, plants couldn't be truly healthy. Nor could we.

In 1942, Albrecht proved his point. Just before World War II, when most Americans ate food grown close to where they lived, he came across Missouri's military draft records and discovered a correlation between recruits considered unfit for military service and soils lacking in minerals. Drawing a line across a map of Missouri, Albrecht overlaid the clusters of rejected men.

His hunch, that the washed-out soils of the southeast, close to the Mississippi River, would produce men of inferior physical capabilities, while the relatively drier (and therefore mineral-rich) soils of northwest Missouri would produce men of better health, proved to be exactly correct. Approximately four hundred men out of one thousand from the southeast were rejected for the draft, while only two hundred of a thousand from the north were. And, as Albrecht predicted, the area in between, where the soil was in fair condition, rejected three hundred recruits.

Alarmed by declining soil fertility at the end of World War II, Albrecht warned that our nation's future was at risk. He called for a major national initiative to restore the health and fertility of America's soils. Instead we went in the opposite direction, by industrializing agriculture. Not surprisingly, vegetables and fruits (and grains, milk, and even animal products) suffered. In the past fifty to seventy years, many vegetables have shown nutrient declines of anywhere from 5 percent to 40 percent.* Researchers now refer to large-scale "biomass dilution"—plants that have such low concentrations of certain nutrients that they do not adequately nourish the people who eat them.

I was once a member of a panel on sustainable food, where I made the point that these declines in nutrient density, especially in the mineral content of soils, were connected to a host of diet-related diseases. A nutritionist in the back of the room took me to task: Foods may have lost some of their trace minerals, he conceded, but because our bodies need so little of these to survive, we excrete those minerals anyway. Trace minerals—zinc, selenium, and copper—are named as such because we don't need a lot of them.

* This, according to Donald Davis, the author of one analysis, is at least partly genetic—the result of breeders selecting for high yield. "When breeders select for high yield," he explains, "they are, in effect, selecting mostly for high carbohydrate with no assurance that dozens of other nutrients and thousands of phytochemicals will all increase in proportion to yield."

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"Instead of talking about the real issue here—how our modern diets include the wrong foods in bad proportions," he said, "you're bemoaning a food system that's succeeded in producing a plentiful, cheap supply of fruits and vegetables—fresh, frozen, canned, and even processed—by sacrificing a few minerals we pee out at the end of the day. I don't know what you're complaining about, and I suppose neither do you."

There was some truth to his critique. In a country where the leading dietary sources of energy are abundant carbohydrates and fats, within a world where 840 million people suffer from chronic hunger, it is difficult to get too worked up about food lacking in micronutrients. A carrot puffed up on nitrates and water is still a carrot with nutritive and caloric benefits. To compare it with a 16.9 mokum is to admit an embarrassment of riches.

But to say we need only a specific amount of certain micronutrients is exactly the kind of reductionist dietary advice that got us into trouble in the first place.

Several years after the nutritionist asked his question, I met with Joan Gussow, former chairwoman of nutrition education at Columbia University, who helped me with the answer. Joan is a longtime analyst and critic of the industrial food system and the woman who famously said, "I prefer butter to margarine because I trust cows more than chemists." She, too, was one of the Fertile Dozen at Laverstoke and served as part of the brain trust that guided the opening of the Stone Barns Center.

She affirmed that soil minerals are the building blocks of human nutrition, and at the core of healthy eating. "We're focused for some reason on single nutrients, on specific, magic bullets for our health," she told me. "But it's the mixture of foods—we call them *diets*, by the way—where the real nutrition comes from."

How would she have answered the nutritionist in the audience? She would have asked a question of her own: How did he know that we need only this much of X and this much of Y, and that we excrete the rest? After all, these days we're no longer concerned only with preventing deficiency

diseases, like scurvy, which can be conquered with a magic bullet such as vitamin C.

Now, she said, "we're talking about degenerative disease, and degenerative disease takes a long, long time to develop. There are no magic bullets. There are only diets that appear to equate eating with a healthy life."

The Western diet does not appear to be one of them. Of the diet-related diseases that have spiked in the past century, the obesity epidemic would seem to have been impossible to predict. And yet, in the 1930s, Albrecht came close. He knew that cows grazing from well-mineralized soils ate balanced diets. But when kept in a barn and fed a predetermined grain ration, they never stopped eating, overindulging in a vain attempt to make up with sheer volume for what they weren't getting in their food. Albrecht believed our bodies would likewise stuff themselves for the same reason. Starved of micronutrients, he said, we will keep eating in the hope of attaining them.

Of course, obesity is influenced by many different things, but John Ikerd, a professor emeritus of agriculture and applied economics at Albrecht's alma mater, the University of Missouri, argues that Albrecht's conclusions about mineral depletion and obesity have never seriously been considered.

"If we humans have this same basic tendency as other animals, as Albrecht suggested, whenever our food choices are limited, we may well consume more of some nutrients than we need in an attempt to get enough of others to meet our basic nutritional requirements," Ikerd once said. "The lack of a few essential nutrients in our diets might leave us feeling hungry even though we have consumed far more calories than is consistent with good health."

Ikerd cites a damning statistic: from 1900 to 1950, Americans' physical activity decreased, as did their caloric consumption. In the second half of the century, they became even less active but ate more. "The sedentary lifestyles of many Americans obviously contribute to the growing epidemic of obesity," he conceded. "However, excessive eating and the resulting excessive weight also contribute to sedentary lifestyles. Many Americans may overeat

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because their food leaves them undernourished. . . . The human species obviously didn't evolve that much over 100 years, but the food system most certainly did."

The connection between depleted soils and obesity is rarely considered. And though scientists now see how well-mineralized soils beget healthy plants, there is still too little knowledge about how plants use those minerals.

"No one understands the mechanism for synthesizing minerals into molecules—no one," Joan told me. But this synthesis is, nonetheless, key to healthy plants and healthy people. "Foods are an evolving mix of metabolizing molecules. Diets represent a whole range. To separate the nutrients out of a diet is to render them—nutritionally, anyway—completely useless." Which is what most nutritionists do. They look at a vegetable or a fruit or a piece of bread and break it down into vitamin components: this gives vitamin A, this provides calcium, this contains the United States Recommended Daily Allowance of folic acid.

Albrecht did not. He worked backward from his observation of healthy people. "Rather than assuming what a healthy diet should be, he looked at healthy people and figured out what made them healthy," Klaas told me. "He could almost always trace it back to healthy soil."

When Joan said that diets represent the whole range of synthesizing molecules, she may well have been talking about how a plant creates flavor. Flavor, as Jack had pointed out, isn't about individual minerals. It isn't calcium or manganese or cobalt or copper. Flavor is the synthesis of all these things. The more minerals available for the plant to synthesize, the more opportunity there is for better flavor.

When we taste something truly delicious, something that is *persistent*, it most likely originated from well-mineralized, biologically rich soils. As it turns out, our taste buds may be far more sensitive than any chemist's tools.

Eliot Coleman would agree. "I'll never forget the night my wife and I sat down to a plate of carrots we had just harvested from the field," he told me

once. "We dug in. And then I just stopped, fork in hand. There was a glow to the orange—it was incredible. I mean, it really glowed, like it was lit up. I just had to sit there and look at it. *Something* was going on. How do you prove a glow? A nutritionist would say, '*No, a carrot is a carrot is a carrot.*' A scientist would say, '*No difference.*' But taste the damn carrot."

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