2 | THE YEAR OF EATING LOCALLY

September. The farmers' market in Middlebury, Vermont, is in absolute fever bloom: sweet sweet corn, big ripe tomatoes; bunches of basil; melons. This is the bounty of our short but intense summer, when the heat of the long days combines with the moisture of these eastern uplands to produce almost anything you could want. It's the great eating moment of the year.

But I'm wandering the market trying to keep the image of midwinter in mind—the short, bitter days of January, when the snow is drifted high against the house and the woodstove is cranking. I'm used to getting the winter's wood in, but not to putting the winter's food by. In our globalized world, it's always summer somewhere, and so we count on the same fever bloom of produce the year round.

For one winter, though, I wanted to try an experiment. I wanted to see if I could make it through the cold months living entirely on the food that comes from where I live, from the valley around Lake Champlain. In summer, it's easy to eat locally; you'd be crazy not to. But this is one of the northernmost valleys in the Lower Forty-eight, and far removed from the vast fields of the Midwest and the irrigated valleys of California where most of our calories come from. I designed my modest experiment to see how much was left of the agricultural infrastructure that once fed people here, and everywhere else, on local food. My experiment was designed, more grandly, to give me some slight hint of what a truly local economy might feel like. Because if the larger society is running up against the realization that More is not necessarily Better, then one of the alternatives is to think on a different scale.

And food may be the place to begin. After all, for almost all people throughout history (and for most people still today), "the economy" is just a fancy way of saying "What's for dinner?" and "Am I having any?" Even today, in a world economy that churns out jet airplanes and iPods and laser guidance systems for parking your car, a Harvard Business School professor recently reported that "fifty percent of the world's assets and consumer expenditure belong to the food system."[1] Half the jobs, too.[2] The "food system" has been made over in the name of efficiency and growth as much as any other: the average bite of food an American eats has traveled fifteen hundred miles before it reaches her lips. I have no illusions about undoing all that; the point of this experiment is not to encourage others to eat an exclusively local diet. (As soon as the winter was over, I returned to a modest banana intake.) It was a small, highly artificial attempt to persuade myself that some other view of "the economy" was even remotely plausible, that in the absence of the industrial food system I wouldn't starve.

All of which explains why I'm here at the market bargaining for canning tomatoes, the Roma plums with perhaps a few blemishes. Though mostly I want to spend the winter buying what's available, I'll put up a certain amount. My friend Amy Trubek volunteers to help. A food anthropologist, she's the head of the Vermont Fresh Network, which partners farmers with chefs; she and her husband, Brad Koehler, one of the heads of Middlebury College's renowned dining halls, also own a small orchard and a big vegetable garden, not to mention a capacious freezer. "A lot of people associate canning with their grandmother, hostage in the kitchen for six weeks," she says.

"But hey, this is the twenty-first century. We can freeze, we can brine, we can Cryovac—we can do all this a hundred different ways." An afternoon's work, with the Red Sox beginning their stretch drive on the radio, and I've got enough tomato sauce frozen in Ziplocs to last me through the winter.

October. Fall lingers on (and the Red Sox, too). Our local food co-op still has the makings of a "normal," which is to say summery, salad; already, though, I'm regarding leaf lettuce with a kind of nostalgia, knowing it's about to disappear from my life.

And I'm regarding two small bins at the bottom of the co-op's bulk section as my lifeline. They're filled with local flour, 59 cents a pound. Once upon a time, the Champlain Valley was the nation's granary—but that was a long time ago indeed, back before the Erie Canal opened the way west and vast rivers of grain began flowing back from the deep topsoil of the Plains. Grain farming all but disappeared from the region; the most basic component of the American diet had to be imported from Nebraska.

But there's always an oddball, and this one's name is Ben Gleason. He is a short and modest man who came to Vermont, like many others, as a part of the back-to-the-land movement of the 1970s. He found an old farm in the Addison County town of Bridport, and he began to plant it in a rotation of hard red organic winter wheat. Last year, for instance, he grew thirty-two tons on thirty-two acres, a perfectly respectable number even by midwestern standards, and he ground all of it with a small, noisy machine in the shed next to his house. It makes economic sense: without any middlemen, he gets all the value from his crop, and so, even on a small farm, he and his wife are able to support their family. I pay 10 cents more a pound for flour than I would at the supermarket, but that's a pretty negligible cost over the course of a year. (If you're using Ben Gleason's flour to make your own bread instead of buying loaves from the store, you'll come out way ahead.) True, he has some idiosyncrasies. He only sells whole wheat flour; grinding white would require another machine, and anyway, as he points out, it's not nearly as good for you. Fortunately, Gleason's wheat is delicious—perfect for pancakes flavorful enough to stand up to the Grade B maple syrup that's the only kind we use. (Grade A, Fancy—that's for tourists. The closer to tar maple syrup is, the better.)

November. The traditional Thanksgiving dinner is also the traditional local foods dinner, at least for this part of the world. Which makes sense, since the Pilgrims weren't in any position to import much food; they just hunkered down with the beige cuisine that begins to predominate as the summer turns to memory. (On Cape Cod, they had cranberries for a flash of deep color; here we have beets, which make a ruby, tangy slaw.)

The self-sufficient all-around farms with which the colonists covered the continent have largely disappeared, at least outside Amish country. Even the tiny local growers in this valley often specialize in order to stay afloat—I can show you a potato farmer in the hills above Rutland with fifty varieties in his three acres, and a bison wrangler on the lakeshore, and an emu rancher. But there is an exception to this trend: the quick spread in the last decade of the "community-supported agriculture" or CSA farm. Consumers pay farmers a few hundred dollars apiece in midwinter and then are supplied with a weekly bin of incredibly diverse vegetables throughout the growing season and deep into the fall. Almost every corner of America now has a CSA nearby, but some of the original operations are in this area, and none produces vegetables more glorious than Golden Russet Farm in Shoreham, where Will and Judy Stevens are busy threshing dried beans when I stop by one afternoon to pick up some squash. But even Will and Judy aren't quite like the farmers of old: they go to the store for their milk.

Not so Mark Gunther and Kristin Kimball, the young proprietors of Essex Farm, on the New York side of the lake. If you want to join their CSA, you pay more like a few thousand

dollars. But when you stop by on Friday afternoons for your pickup, you don't get just vegetables: they have a few milking cows, so they supply milk and cheese and butter; they have a small herd of grass-fed cattle, so there are steaks and burgers; the snorting tribe of pigs behind the barn provides bacon and lard; there are chickens and turkeys and even bees. Except for paper towels and dental floss, you'd never have to set foot in a store again. Think Currier and Ives, complete with a team of big Belgians instead of a tractor. "I don't think my intent is to create an historical farm, though," Mark insists. "There's nothing inherent about modern ways that I don't support. I'm trying to find out ways to increase the quality of my life." You can't leave the farm without Mark loading your trunk full of food—"Do you have room for another chicken there?"—and all of it tastes of the place. As you bump out of the driveway, a look in the rearview mirror reveals Mark juggling carrots and grinning. "Occasionally I feel like I'm doing some work," he says. "But usually it feels more like entertainment for myself."

Is this realistic? Could you feed Manhattan in this fashion? You could not; every place is different. (And Manhattan is lucky to have New Jersey, the Garden State, right next door, with some of the best truck-farming soil and weather anywhere on earth. In fact, as we shall see, urban areas around the world are rediscovering the cropland on their outskirts, with impressive results.) But you could feed the village of Essex, New York, this way: Mark figures the fifty acres he and Kristin are farming can support ten or twelve families at least, a reminder of just how fertile the earth can be in the right hands. He's making lunch as he calculates, whistling over a skillet of cheeseburgers. "The lard is from the pig we called Moose, who was the runt of the litter last year. And the bull, Charlie, we finished him on grass and ate most of him at our wedding. And there's some Delia and Melissa in the cheese." It's not just realistic, it's real. And delicious.

December. Here's what I'm missing—not grapefruit, not

chocolate: oats. And their absence helps illustrate what's happened to American agriculture, and what would be required to change it a little bit.

Once upon a time, oats were everywhere; people grew them for their horses, and for themselves. But oats aren't easy to deal with. Wheat you simply grind up, but oats have a hull that needs removing, and they need to be steamed, and dried, and rolled. You can do that more efficiently on a vast scale in places like Saskatoon, Saskatchewan, where a single mill turns out a million pounds of oat products a day. Such scale quickly undercut local markets, and soon no one was milling oats in the Champlain Valley—just as no one was raising pork, or canning tomatoes, or doing any of the other things that a local food economy would require. For the moment, large-scale, centralized farming works. But that may change if the price of oil (the lifeblood of industrial agriculture) continues to climb, or if the climate keeps changing rapidly, or if global politics deteriorates. Even now, stubborn people keep trying to rebuild smaller-scale food networks, but it's hard to swim against the tide of cheap good that keeps flowing in.

A few years ago a Vermonter named Andrew Leinoff decided to go into oats. He and a friend found some old equipment and started experimenting. They worked out a good rotation for their fields—soybeans, then buckwheat, then the oats—and they eventually managed to make their ancient machinery work at least sporadically. ("One time my friend turned on the huller and it blew apart," Leinoff recalled. "Missed him by inches and made a big hole in the roof of the barn.") After several seasons of struggling to overcome all the problems of a startup, they gave up, and a little bitterly. The state's department of agriculture talks a good game—the governor has a public service ad on the radio urging Vermonters to buy 10 percent of their food from within the state—but it spends most of its time and money propping up the state's slowly withering dairy industry, not supporting the pioneers trying to build what

comes next. The only thing the oat farmers got from the state was "these bizarre tax notices fining us $250 because we hadn't filed something that said we had no income."

As a result, no oats for me, not until I cheated and found a tiny farm just across the Canadian border. Which makes this an appropriate place to interrupt my winter's tale, finely balanced between delight and frustration. It's the same balance that almost everyone eventually reaches when they start trying to change our food economy—indeed, any facet of our economy. I'm able to taste a different future, but the weight of the present is strong indeed. And that weight comes precisely from the remarkable success of our current food system, at least when measured in the ways we're used to measuring.

MODERN AGRICULTURE PRODUCES A LOT OF FOOD, AND PRODUCES it cheaply, two feats that people have spent all of human history trying to achieve.

The engine of this achievement has been, for a century, relentless consolidation and concentration, a process that is by now very nearly complete in the United States and is still accelerating elsewhere. Four companies slaughter 81 percent of American beef.[3] Cargill, Inc., controls 45 percent of the globe's grain trade, while its competitor Archer Daniels Midland controls another 30 percent.[4] Name your commodity: as the *New York Times* reported recently, the number of potato farmers in Idaho has fallen by half in the last fifteen years, to no more than eight hundred. (A typical farmer there may have eight tractors worth $130,000 apiece; he's likely to use global positioning satellites to make sure his rows are straight. "With all that, you need 1,500 to 2,500 acres to make a decent living," one explained.)[5] Eighty-nine percent of American chickens are produced under contract to big companies, usually in broiler houses up to five hundred feet long holding thirty thousand or more birds. Four multinational companies control over 70 percent

of fluid milk sales in the United States, and one Ohio "farm" produces 3 billion eggs per year.[6] Four firms control 85 percent of global coffee roasting, and a small group of multinationals handles 80 percent of the world trade in cocoa, pineapples, tea, and bananas. The merger of Philip Morris and Nabisco in 2000 created a food conglomerate that collects nearly 10 cents of every dollar an American consumer spends on food. Meanwhile, five companies control 75 percent of the global vegetable seed market, and their grip on the market is tightening as the seed companies patent more and more genetically modified varieties and prevent seed saving.[7] As a former Monsanto executive boasted not long ago, "What you are seeing is not just a consolidation of seed companies, it's really a consolidation of the entire food chain."[8]

The same forces that have created giant farms and processing plants have also worked to consolidate the retail end of the food business. As one Wal-Mart "meat procurement officer" said, "We've tried to apply our value proposition to all the meat products that we sell. The same principles of value, price, and quality that apply to things like television sets also apply to food."[9] Indeed—and Wal-Mart is now the largest seller of food in this country (and on this planet). It's not just in the United States that such forces play out. In Britain, the four biggest supermarket chains now control 80 percent of the food consumed there, and as a result the number of produce suppliers to the average supermarket chains has fallen from 800 in 1987 to fewer than 80 today. The consolidation continues—80 percent of the British potato crop comes from 250 growers, down from 5,000 in 2001, in part because the requirements for what constitutes an "acceptable" vegetable keep getting tighter.[10] Want to sell tomatoes? The store will take them only if they're between 53 and 63 millimeters in diameter. That 10-millimeter band (about the size of a pencil eraser) disqualified lots of tomatoes; more were tossed out because they were at "different color stages" or had "slightly chewy skin."[11]

This system of consolidation, which is working its way quickly into the developing world, is the epitome of a certain kind of efficiency, Adam Smith raised to the *n*th degree. People who specialize in 56-millimeter tomatoes get very good at growing them, especially when they're being constantly reminded to lower their price lest the buyer go elsewhere. Partly as a result of all this, the world produces 322 kilograms per person per year of grain in 2004, the biggest harvest ever, and we can walk into a supermarket and find a bounty of lovely food from all around the world at any season. The price of all that food has never been lower: Americans spend 11 percent of their paychecks on food, less than half what their grandparents spent before World War II.[12] As the dean of the College of Agriculture at the University of Maryland noted recently, "Large farms simply produce commodities at lower cost."[13] We've got what everyone who ever lived always wanted—plenty. End of story.

OR NOT. TO CREATE ALL THOSE EFFICIENCIES, AN AWFUL LOT OF inefficiencies had to be eliminated, and that process has not been free of pain. Cheap and plentiful food may well have been worth it, but let's at least itemize the various costs, especially since the process, though nearly complete in this country, is still in earlier stages in various spots around the globe. The first and most obvious of these costs has been damage to communities—to the people who were no longer necessary, and to the communities that they had built. It's hard to calculate this damage; in fact, many have questioned whether it is damage at all, or just change. Still, the numbers are stark. Since the end of World War II, America has lost a farm about every half hour, mostly because farming has grown more efficient.[14] Output went up, prices went down, and on the typical Iowa farm "the farmer's profit margin dropped from 35 percent in 1950 to nine percent today," according to the Worldwatch

Institute researcher Brian Halweil. To generate the same income as it did in 1950, a farm today would need to be roughly four times as large. And that's exactly what has happened: a few farmers, more skilled at financing or with better access to capital, bought out their neighbors. Before long, most of the real money was in the value-added phase: turning corn into corn syrup and then into Coca-Cola. "Tractor makers, agrochemical firms, seed companies, food processors, and supermarkets take most of what is spent on food, leaving the farmer less than ten cents of the typical food dollar," says Halweil.[15] Ezra Taft Benson, Dwight D. Eisenhower's secretary of agriculture, exhorted farmers to "get big or get out." They complied, but in the 1970s Nixon's agriculture secretary, Earl Butz, told them to "get bigger, get better, or get out." Everyone took his advice, too, and by 1980 there were so few farmers left in the country that the Census Bureau no longer bothered to list farming as one of the occupations you could check off on its form. American farmers over the age of sixty-five outnumber those under thirty-five by nearly six to one.[16]

The "farmers" who survive in this process are often living truly miserable lives. Imagine, for instance, what it's like to rear chickens for a huge grower like Perdue. The company doesn't own farms; instead, it contracts with farmers, telling them precisely how to build their sheds, what to feed the hens, how often to supplement with antibiotics. The farmer owns the land and the equipment, but Perdue can inspect them at any time. Most of the farmers, according to an investigative series in the *Baltimore Sun*, were lured into the business by "sophisticated company sales pitches promising independence and a middle-class income," but soon find themselves "landowning serfs in an agricultural feudal system." In return for a $250,000 start-up investment of his savings, the average contract chicken farmer takes in an annual net income of $8,160. No benefits—the farmer is an independent contractor—just the right to assume "round-the-clock responsibility, daily

collecting dead birds by hand during strolls through dust and ankle-deep manure. A farmer battles heat waves, power outages, and outbreaks of avian disease, and his every move is controlled by the vagaries of a contract that can be canceled virtually anytime, cutting income to zero."[17]

I get to watch this process close up. I live in Vermont, long a dairy state—but the number of farms drops every year. In 2004, we lost 81 dairies, bringing the total below 1,300. But those remaining were bigger, more efficient. The state's agriculture secretary, Steve Kerr, seemed unruffled: "There is always a sadness in town when something changes, when the barn that had cows in it doesn't have cows anymore," he said. "But agriculture, like every business, changes over time. The year that will really worry me is the year our milk production takes a real dive. That hasn't happened."[18] Indeed, the most efficient production scheme would be a single giant cow with an udder the size of a volcano, squirting milk directly into a central processing plant. That's more or less where the current system is headed: Thomas Dorr, the current U.S. undersecretary of agriculture for rural development, believes "that the right scale for farms in the future will be about 200,000 acres of cropland under a single manager."[19] (In such a world, Vermont would have about five farms.) The same phenomenon is at work in other countries. In Britain, a thousand farmers and farmworkers leave the land each week; one expert recommends that British farmers join together in "Soviet-style collectives" of up to twenty thousand acres in order to produce commodity crops at world prices.[20] France lost half its farmers between 1982 and 1999, and in Germany the number of farmers declined by a quarter in the 1990s.[21] In Poland, 70 percent of farms may disappear as the country is absorbed into the European Union; in the Philippines, 1.2 million farmworkers, 10 percent of the total, lost their jobs in the single year between July 1999 and July 2000.[22]

To many economists, these numbers represent the "creative destruction" inherent in a market economy. Steven Blank of

the University of California at Davis predicts that America may soon "get out of the food business" because it "will become unprofitable to tie up resources in farming and ranching" that could be better invested elsewhere. Our country is merely "moving up the Economic Food Chain," Blank says. "America doing agriculture is like a Ph.D. doing child's work—we can do it, but it is a waste. Much of our labor, capital, and management resources that remain in agriculture are there by choice but could be better invested elsewhere." Soon, he predicts, only those forms of agriculture "compatible with urban life" will still matter in America; "the main entries on that list include golf courses, nurseries, and turf farms." A golfer, he notes, pays $275 to "wander around on the turf at Pebble Beach for about four hours, and there is a waiting list to do it. How often do people pay farmers for the opportunity to wander around in their fields?"[23] Blank is an extreme example, but standard economic thinking basically agrees: the country is better off because people have been freed from working in the fields to do something "more productive." And surely some of those freed people agree; there have always been lots of farm kids seeking any way into some other, easier life. The 60 percent of Americans who were farming a hundred years ago and aren't now have built most of our modern way of life.

But, the costs have been real. As farms declined, so, too, did the communities around them. Even in the prosperous 1990s, farm consolidation was changing rural America: 676 of the nation's 3,141 counties lost population, and the drain was so strong in the northern Great Plains that "an area the size of the original Louisiana Purchase again qualifies for the 'frontier' designation that the Census Bureau gave remote regions before the great waves of settlement in the 19th century." Poverty rates, the journalist John Nichols adds, are now higher in vast stretches of the "heartland" than in inner cities. Nine of the ten counties in America with the lowest per capita income are in farm states west of the Mississippi.[24]

The specialization and consolidation are so intense that sociologists now designate many parts of rural America "food deserts," dependent on convenience stores and without access to fresh produce. The director of the nation's largest food relief charity, Second Harvest, describes Midwesterners "going to a food bank for a box of cornflakes to feed their children in a community where thousands of acres are devoted to growing corn."[25] Everything in town dries up and disappears: 20 percent of the prairie churches in the Dakotas now stand vacant.[26] It may be simply sentimental to mourn this loss, for America is rich and productive enough that many of those forced from the countryside find other things to do, most of them easier than farming. But since the same efficiencies are quickly spreading worldwide, and since half the world's people currently work as farmers, it's worth at least wondering what the result will be elsewhere, where the first stop (and often the permanent stop) for displaced peasants is a cardboard box on the edge of the capital city.

IF THE DAMAGE TO COMMUNITY IS ARGUABLE, AN INDUSTRIALized food system has other costs that are both more prosaic and more obvious. Part of the reason for that low, low price for food is that we pay many fewer farmers a smaller percentage of our food dollars. And food is cheap partly thanks to efficiencies like speeding up the processing lines where animals are slaughtered. According to Human Rights Watch, as the Bush administration has turned a blind eye to safety standards and as the power of the meatpacking unions to set conditions has eroded, "Workers in the industry now face a one-in-five chance of severe disability or death on the job."[27] When Tyson opened a plant in Missouri in 1995, it couldn't find enough immigrant labor, so the state began sending welfare recipients to work there as a way to get them off the rolls. "The first job they get is the 'puller' job—pulling the internal organs out," one state bureaucrat explained. "A lot of these workers will lose their fingernails in two to three weeks from the bacteria in the chicken fat."[28]

Did you ever wonder how lobster could be so wondrously cheap at those chain restaurants next to the mall? Despite the old-fashioned lobster traps hanging on the wall, what you're eating isn't actually Maine lobster; it's spiny or rock lobster from the waters off Central America. Close to 100 percent of the divers who harvest those lobsters off the sea bottom show signs of neurological damage, according to a 1999 World Bank report, because they use ancient scuba equipment, without depth gauges or even an indicator to tell them how much air they have left, and because, as the lobsters have gotten scarcer thanks to the endless all-you-can-eat lobster buffets back home, the divers have fished out the 40-foot depths. They're down at 120 feet, 130 feet.[29]

In some places, the abuse of workers gets even more basic. On Brazil's frontier, there's a problem with slavery: as many as fifty thousand people engaged in clearing the Amazon jungle are effectively enslaved. ConAgra, one of the biggest food processors on earth, bought beef from that land once it was cleared and sold it in cans with the Mary Kitchen label. A spokeswoman, Kay Carpenter, said the company was "several steps removed" from the slaveholders. Another large agribusiness firm, Cargill, was accused in 2004 of buying soybeans from Brazilian slave farms; its spokeswoman said in response, "I think it is unfair of folks to point at Cargill and say Cargill is solely responsible for actions other people take."[30]

Of course, it's unfair. The logic of our current way of looking at the world is what points companies in this direction. It is more efficient to pay farmers the least we can get away with, to get the most possible work out of chicken pluckers, to not worry overmuch about exactly where that lobster came from. We are delivering huge quantities of food, cheaply. If

people were paid more along the way, that efficiency would be compromised.

It also makes a certain kind of sense to abuse the environment along the way, again because doing so is efficient. For instance, the cheapest way to raise hogs is all in the same place, where one worker can "take care" of tens of thousands of animals. But this concentrates their waste in one place, where instead of being useful fertilizer to spread on crop fields it becomes a toxic threat. Hogs produce a lot of waste, much more than people do. One farm in Utah, with 1.5 million porkers, has a sewage problem larger than that of the city of Los Angeles.[31] In North Carolina, one of the centers of what boosters call Big Pig, hogs outnumber citizens, and they produce more fecal waste than California, New York, and Washington combined.[32] As one official for the American Farm Bureau puts it, "It's not like farmers and ranchers wake up one morning and say 'I want 10,000 pigs in one spot.' But we're in a world market. And if we're going to compete internationally, we have to be low-cost producers, and we have to do so for products that consumers demand." Attempts to alleviate the symptoms often only ends up adding to the consolidation; new rules about the smell from sewage lagoons, for instance, end up favoring "the largest farms that will be able to afford new technology to mask odors."[33]

But there's also another potential cost to our food system, one we've just begun to understand in the wake of 9/11: any enterprise so centralized is exquisitely vulnerable to sabotage. Lawrence Wein, a professor of management science at Stanford University's business school, offered a small example in the spring of 2005: say a terrorist, using instruction manuals that can be found on the Internet, fills a one-gallon jug with a sludgy substance containing a few grams of botulinum toxin. He sneaks onto a dairy farm and pours his jug into an unlocked milk tank, which is then picked up a by a milk truck and taken to a giant dairy-processing factory. About 100,000 gallons of

milk go through an average plant's raw-milk silo between cleanings, Wein estimates, which means 400,000 cartons of contaminated milk can be shipped out around the country. And since botulism doesn't sicken its victims for forty-eight hours, it will take a while for anyone to notice.[34] This is not simply some personal nightmare: when Tommy Thompson announced his resignation as secretary of health and human services in 2004, he said in his final press briefing: "For the life of me, I cannot understand why the terrorists have not attacked our food supply, because it is so easy to do."[35]

Even apart from terrorists, the centralized food system we've built presents risks. "The industrialization of poultry is the nub of the problem" of avian flu, says Kennedy Shortridge, a Hong Kong microbiologist who has spent three decades studying influenza viruses.[36] Concentrated agriculture also manages to make us sick on a fairly regular, if less dramatic, basis. Seventy-six million Americans fall ill annually from food-borne illness; 300,000 are hospitalized; 5,000 die.[37] Salmonella is the biggest culprit, and its prevalence has doubled since the 1970s, which makes sense when you consider the enormous poultry barns and cattle feedlots that grew up in those years. Half the chicken on sale in British supermarkets is contaminated with campylobacter, the journalist Felicity Lawrence recently reported; this is, in part, because the live birds are stacked in enormous towers of cages as they await slaughter, so the waste from the top deck rains down on those below. "Look, if you are going to process poultry at that price, there's not much you can do," one microbiologist finally told Lawrence, a little impatiently. "The factories are designed to get them through fast. People want cheap food."[38]

PROBLEMS LIKE THESE—HUGE SEWAGE LAGOONS, MISERABLE animals, abused workers, vulnerability to sabotage and to salmonella—are not, perhaps, inherent problems. You could

envision a huge global food system that was willing to trade a little efficiency for slightly more humane working conditions or slightly better sewage treatment.

There is a deeper issue, though, which can't be addressed without changing pretty much everything about the way we eat: we are running out of the two basic ingredients we need to grow crops on an industrial scale. These are oil and water, and in modern agriculture they mix to provide the giant harvests of cheap food we've come to count on. But they're not to be taken for granted.

Let's look at water first. Seventy percent of the water used by human beings goes to irrigate crops. Water demand has tripled in the last half century; we have slaked this thirst by pumping from aquifers, underground layers of porous rock or sand containing water, into which wells can be sunk. The diesel-driven and electrically powered pumps that make the extraction of water possible became available around the world at roughly the same time; hence it is no surprise, writes the eco-statistician Lester Brown, that we now face "the near-simultaneous depletion of aquifers."

In China, recent surveys show that the water table under the North China Plain, which produces half the country's wheat and a third of its corn, is falling fast. Every day in the countryside north of Beijing you run across people whose wells have suddenly gone dry; a World Bank study reports that wells drilled in the area now have to descend a thousand meters, more than half a mile, to tap fresh water. India is also overpumping its aquifers; studies of the wells in Rajasthan, for example, suggest the water table there has fallen more than 130 feet over the last two decades. And similar drawdowns seem to be taking place around the world. Villages in eastern Iran are being abandoned as wells go dry, and the Saudis, who used mile-deep wells to create, among other follies, a large-scale dairy industry, are now cutting back sharply on water use. In essence, Brown writes, we have created a food bubble

economy, artificially inflating food production by means of an unsustainable reliance on underground water. The pumping of groundwater has generated tremendous crop yields, even compared with surface-water irrigation from dams and canals, which can't be as easily turned on and off at just the right moment. But when the water starts to run dry, that free ride is over, and farmers will have to return to growing what they can with the water that falls on their regions. For China, India, Pakistan, Mexico, and Saudi Arabia, Brown says, the question "is not whether the bubble will burst, but when."

We're used to thinking of water as key to farming. But we reflect less often on an equally critical fact: our food arrives at the table marinated in oil—crude oil. Cheap and abundant fossil fuel has shaped the farming system we've come to think of as normal; it's the main reason you can go to the store and get anything you want at any time and for not much money. And since, as we've seen, we may be both running out of oil and running out of atmosphere to store carbon, our agricultural system may be far more vulnerable than we imagine.

Agriculture is, and always has been, energy intensive. For a long time, that meant using the sun's energy to grow food that in turn powered the human and animal muscles necessary to do the work of plowing and planting and harvesting. New inventions—the scythe, the moldboard plow—made that energy go a little further. In the early twentieth century, though, the widespread use of fossil fuels changed the whole equation. Crucially, in 1909 a pair of German chemists named Fritz Haber and Carl Bosch invented a process to synthesize ammonia from atmospheric nitrogen and the hydrogen in fossil fuels; today, their process, mostly using natural gas as a feedstock, produces 150 million tons of ammonia-based fertilizer each year, which adds as much nitrogen to soil as all natural sources combined. Take that away and we'd notice. Meanwhile, almost simultaneously with the invention of artificial fertilizer, farms around the developed world were

converting to tractors, replacing horsepower with oil power. In the 1890s, roughly one-quarter of cropland in the United States was used to grow grain to feed horses, almost all of which worked on farms. Cheap oil freed that land for growing food for humans.[39] When, in the 1960s, we exported this industrialized agricultural system to the Third World, we called it the green revolution.

Because of its reliance on cheap energy, the efficiency of our vast farms and the food system they underwrite is in one sense an illusion, and perhaps a very temporary one. The number of farmers has fallen from half the American population to about 1 percent, and in essence those missing farmers have been replaced with oil. We might see fossil fuel as playing the same role that slaves played in early American agriculture—a "natural resource" that comes cheap. It takes half a gallon of oil to produce a bushel of midwestern hybrid corn; a quarter of it is used to make fertilizer, 35 percent to power the farm machinery, 7 percent to irrigate the field, and the rest to make pesticides, to dry grain, and to perform all the other tasks of industrial farming.[40] There aren't many people on that farm, but there's all kinds of machinery, and every bit of it is burning fuel. Here's the math: between 1910 and 1983, U.S. corn yields grew 346 percent. Energy consumption for agriculture increased 810 percent.[41]

But farming proper is the least of it. Processing, packaging, and distributing the food around the nation and the world consumes four times again as much energy. The numbers are astounding: the average bite of American food has traveled more than 1,500 miles before it reaches your lips, changing hands an average of six times along the way.[42] One study showed that in Iowa—center of the agricultural heartland, the place Americans think of when we think of farms—the average carrot had come 1,690 miles, from California, the average potato 1,292 miles, from Idaho, and the average chuck roast over 600 miles, from Colorado.[43] None of this makes much sense except by

the standards of lowest-price economics. The Swedish Food Institute, for instance, discovered that growing and distributing a pound of frozen peas required 10 times as much energy as the peas contained.[44] Say you grow a head of iceberg lettuce in the Salinas Valley of California and ship it back east: you use 36 times as many calories of fossil energy as the lettuce actually contains. Ship it to London, and you use 127 times as many calories.[45] A pound of grapes flown in from Chile effectively gives off six pounds of carbon dioxide.[46] (Needless to say, the fastest-growing part of the food business is shipment by refrigerated plane.)[47] If what you're eating comes in a package, then the calculations get really wild: to package a box of breakfast cereal requires 7 times as much energy as the cereal contains.[48] Bottled water is, of course, the champion of this kind of equation, since it delivers zero calories. The amount of water traded worldwide has doubled each decade since the 1970s; Californians alone (almost all of whom have access to clean tap water) now throw away 1.2 billion single-serving water bottles annually.[49]

The international food trade just keeps increasing. In the last four decades, the tonnage of food shipped between countries has grown fourfold, while human population has barely doubled.[50] Seventy-five percent of the apples for sale in New York City come from the West Coast or overseas, even though New York State produces ten times as many apples as the residents of the Big Apple consume. In England, farmers ship roughly the same amount of milk, pork, and lamb abroad as British supermarkets import, in what agricultural economists call a food swap. As Herman Daly once wrote, "Americans import Danish sugar cookies, and Danes import American sugar cookies. Exchanging recipes would surely be more efficient."[51] In much of the world, 40 percent of the truck traffic comes from the shuttling of food over long distances.[52]

Here's the bottom line: if the oil runs out, we won't be able to farm or trade this way any longer. And if we took global

warming seriously, we'd stop doing it right now: compared with regional and local food systems, our national and international model releases five to seventeen times more carbon dioxide into the atmosphere.[53] A Japanese study found that eating local food would be the equivalent of cutting household energy use by 20 percent.[54] But what a scary proposition. Because, for all its flaws, the food system we have now manages to more or less feed most of the earth's population. If we didn't have vast factory farms, if we didn't have superefficient agriculture, then we'd starve. Modern, energy-intensive agriculture has "kept more than one billion people from hunger, starvation, or even death," observes Norman Borlaug, the scientist often described as the father of the green revolution. There are still 800 million hungry people to feed, he notes, but not to fear: "New high-yielding, disease- and insect-resistant seeds, new products to restore soil fertility and control pests, and a succession of agricultural machines can ease drudgery and speed everything from planting to harvesting."[55] In other words, pour on the oil, with a side order of biotech. We're in a box.

OR ARE WE? THIS IS A KEY POINT: WE ASSUME, BECAUSE IT MAKES a certain kind of intuitive sense, that industrialized farming is the most productive farming. I mean, if I sit on my porch whittling toothpicks with my Swiss Army knife, I can produce a hundred in a day. If I install a toothpick-whittling machine, I can produce a thousand in an hour. By analogy, a vast Midwestern field filled with high-tech equipment ought to produce more food than someone with a hoe in a small garden. As it turns out, however, this simply isn't true. If all you are worried about is the greatest yield per acre, then *smaller farms produce more food*. Which, if you think about it some more, makes sense. If you are one guy on a tractor responsible for thousands of acres, you grow your corn and that's all you can do: one pass after another with the gargantuan machines across your sea of

crop. But if you're working on ten acres, then you have time to really know the land, and to make it work harder. You can intercrop all kinds of plants: their roots will go to different depths, or they'll thrive in each other's shade, or they'll make use of different nutrients in the soil. You can also walk your fields, over and over, *noticing*. As one small farmer recently wrote in *Farming* magazine, spending part of every day in the pasture gives you a "grass eye," "a keen awareness" of where small seeps of water are muddying the fields, or whether "earthworms and other soil life are properly disposing of cow pies." Yellow clover leaves signify a sulfur deficiency; an abundance of dandelions means a shortage of calcium. "Every spot or plant in the pasture," he says, "is trying to tell us something."[56] Does this sound like hippie nonsense? According to the most recent USDA Census of Agriculture, smaller farms produce far more food per acre, whether you measure in tons, calories, or dollars. They use land, water, and oil much more efficiently; if they have animals, the manure is a gift, not a threat to public health. "In terms of converting inputs into outputs, society would be better off with small-scale farmers," writes Brian Halweil. "As population continues to grow in many nations, and the amount of farmland and water available to each person continues to shrink, a small farm structure may become central to feeding the planet."[57]

But if this is true, then why don't we have more small farms? Why the relentless consolidation? There are many reasons, including the way farm subsidies have been structured, the big guys' easier access to bank loans, and the convenience for politically connected food processors of dealing with a few big operations. But the basic reason is this: we have substituted oil for people. The small farm grows more food per acre, but only because it uses more people per acre—low-input farming in Great Britain employs twice as many people per acre, according to a 2005 study.[58] Since World War I, it has been cheaper to use oil than to use people. Cheap oil has

meant cheap synthetic fertilizer, big tractors, and everything else we associate with modern agriculture. You get more food per *acre* with small farms; more food per *dollar* with big ones.

What about conventional versus organic? Could we take away the fossil fuel (which means, most of all, the synthetic fertilizer), put people back on the land in larger numbers, and have enough for dinner? The proponents of conventional agriculture scoff at the idea: Dennis Avery, director of Center for Global Food Issues, says you'd need so much land to grow forage for the animals providing the manure that a world of low-input organic farmers would only work if you were "willing to destroy three billion living human beings and forcibly abort most of the babies now being born in the world."[59] However, organic farming techniques have steadily improved in recent decades, especially in their use of cover crops, or "green manures," which enrich the soil without needing animal waste.

The best data come from an English agronomist named Jules Pretty, who has studied two hundred "sustainable agriculture" projects in fifty-two countries around the world. They might not pass the U.S. standards for organic certification, but they're all low-input, using far less energy and chemicals than industrialized farming. "We calculate that almost nine million farmers were using sustainable practices on about 29 million hectares, more than 98 percent of which emerged in the past decade," he noted in 2002. "We found that sustainable agriculture has led to an average 93 percent increase in per hectare food production." These were not tiny, isolated demonstration farms; Pretty studied fourteen projects where 146,000 farmers were raising potato, sweet potato, and cassava, and he found that practices like cover-cropping and fighting pests with natural adversaries had increased production 150 percent, to seventeen tons per household. With 4.5 million grain farmers, average yields rose 73 percent.[60] When Indonesian rice farmers switched away from pesticides, he found, their yields stayed the same but their costs fell sharply.[61]

And over time, instead of eroding soil or drying up aquifers, as industrial agriculture does, small-scale, low-input farming yields new benefits. Pretty describes a hillside farm on the edge of a remote village in central Honduras, where in the late 1980s the farms were poor-quality pasture and cornfields, and people saw migrating to the city as their only hope. No child in the village had ever been to high school. But one local farmer, Elias Zelaya, was trained by a small nonprofit organization in some of the new sustainable agriculture techniques. He started intercropping beans with his corn; the nitrogen they fixed improved both his yield and his soil. Over the years he's added twenty-eight types of crops and trees to his small farm, along with pigs, chicken, rabbits, cattle, and horses. "The effect is remarkable," says Pretty. "The unimproved soils on the edge of Elias' farm are no more than a few centimeters deep, and beneath it is hard bedrock. But in the fields where Elias grows legumes as green manures and uses composts, the soil is thick, dark, and spongy to the step. In some places on the farm, the soil is more than half a meter deep."[62]

Many of the modern sustainable practices will seem familiar to American backyard gardeners. In Kenya, the Association for Better Land Husbandry found that farmers who built raised beds could produce enough vegetables to see them though the dry season. "A considerable investment in labor is required," as anyone who has double-dug tomato beds can attest. But once they're dug, and once you've begun to enrich them with compost—well, you can grow an awful lot. According to one review of twenty-six Kenyan communities, "Three-quarters of participating households are now free from hunger during the year, and the proportion having to buy vegetables has fallen from 85 percent to 11 percent."[63] Every year new techniques appear. Velvetbean, a green manure, fixes so much nitrogen that on the Central American farms using it corn yields have risen two or three times; certain cowpeas increase the yields of Thai rice farmers by as

much as a fifth. This is not simple peasant agriculture; in fact, it's far more complex than just following the fertilizer or spraying schedule that the nice man from the company hands you when you fork over your cash. But farmer-run schools have sprung up in country after country to spread the new techniques, and the longer that small farmers experiment with the new ideas, the more improvement they find. Take fish ponds—you see them across Asia and Africa, newly dug pools for raising grass-eating fish like carp. In Bangladesh, I've seen them built beneath chicken coops so that the poultry waste will fall through the bottom of the cages and fertilize the weeds that the fish then consume. In Malawi, six years after farmers started building such ponds, total calorie yields had nearly doubled. In the words of one expert, "As farmers gain a greater understanding of how this new system functions, and an appreciation of its potential, they become increasingly able to guide further evolution towards increasing productivity and profitability."[64]

"I acknowledge," says Pretty, "that all this may sound too good to be true for those who would disbelieve these advances. Many still believe that food production and nature must be separated, that 'agroecological' approaches offer only marginal opportunities to increase food production, and that industrialized approaches represent the best, and perhaps only, way forward. However, prevailing views have changed substantially in just the last decade."[65]

The new farming technologies are perhaps the most exciting new "inventions" of our age—more important, in the long run, than the iPod or maybe even the Internet. They *do* sound too good to be true. But as it happens, the world has offered an unexpected large-scale test of these possibilities in the last decade, one of those strange accidents with wide-reaching consequences. The unlikely scene of this experiment is Havana.

THE PICTURES HANGING IN HAVANA'S MUSEUM OF THE REVOLUtion document the rise (or, depending on your perspective, the fall) of Cuba in the years after Fidel Castro took power, in 1959. You can walk through gallery after gallery gazing upon the stock images of socialist glory: "anti-imperialist volunteers" fighting in Angola; Cuban boxers winning Olympic medals; five patients at a time undergoing eye surgery using a "method created by Soviet academician Fyodorov." Mostly, though, there are pictures of farm equipment. "Manual operation is replaced by mechanized processes," reads the caption under a picture of some heavy Marxist metal cruising a vast field. Another caption boasts that by 1990, seven bulk-sugar terminals had been built, each with a shipping capacity of seventy-five thousand tons a day. In true Soviet style, the Cubans were demonstrating a deeply held socialist belief that salvation lay in the size of the harvest, in the number of tractors, and in the glorious heroic machinery that would straighten the tired backs of an oppressed peasantry—and so I learned that within thirty years of the people's uprising, the sugarcane industry alone employed 2,850 lifting machines, 12,278 tractors, 29,857 carts, and 4,277 combines. Industrial agriculture was the cornerstone of communism, as dear to Castro as it is to Cargill.

But then I turned a corner and the pictures changed. The sharply focused shots of combines and Olympians now were muddied, as if Cubans had forgotten how to print photos or, as was more likely the case, had run short of darkroom chemicals. I had reached the gallery of the "Special Period." That is to say, I had reached the point in Cuban history where everything came undone. With the sudden collapse of the Soviet Union, Cuba fell off a cliff of its own and became the first place in the world to face peak oil. All those carts and combines had been the products of an insane "economics" underwritten by the Eastern Bloc for ideological purposes. Castro spent three decades growing sugar and shipping it to Russia and East Germany, both of which paid a price well above the

world level, and both of which sent the ships back to Havana filled with wheat, rice, oil, and more tractors. When all that disappeared, almost literally overnight, Cuba had nowhere to turn. The new Russia no longer wanted to pay a premium on Cuban sugar for the simple glory of supporting a tropical version of its Leninist past. The United States, Cuba's closest neighbor, enforced a strict trade embargo (which it strengthened in 1992, and again in 1996) and Cuba had next to no foreign exchange with anyone else.

In other words, Cuba truly became an island. Not just a real island, surrounded by water, but something much rarer: an island outside the international economic system, a moon base whose supply ships had suddenly stopped coming. There were other deeply isolated places on the planet, such as North Korea and Burma, but not many. And so most observers waited impatiently for the country to collapse. No island is an island, after all, not in a global world. The *New York Times Magazine* ran a story titled "The Last Days of Castro's Cuba," and nowhere did the future look bleaker than on the farm and in the market.

During the Soviet era, much of what Cubans ate had come straight from Eastern Europe, and most of the rest was grown industrial style, on big state farms. All those combines needed fuel and spare parts, and all those long rows of grain and vegetables needed pesticides and fertilizer, none of which were available any longer. In 1989, according to the United Nations Food and Agriculture Organization, the average Cuban was eating 3,000 calories per day. Four years later, that figure had fallen to 1,900. It was as if Cuba suddenly had to skip one meal a day, every day, week after month after year. The host of one cooking show on the shortened TV schedule urged Cubans to fry up "steaks" made from grapefruit peels covered in bread crumbs. "I lost twenty pounds myself," said Fernando Funes, a government agronomist. The Cubans seemed to be proving that indeed you couldn't survive without "modern" agriculture.

But that was then. Now, looking across the table, I could see that Fernando Funes had since gained back that twenty pounds. In fact, he had a little paunch, as do many Cuban men of a certain age. What happened was simple, if unexpected. Cuba learned to stop exporting sugar and instead started raising its own food again, growing it on small private farms and in thousands of pocket-sized urban market gardens—and, since the country lacked chemicals and fertilizers, much of that food became de facto organic. Somehow, just as Jules Pretty's examples from around the world predicted, the combination worked. Cubans produce as much food today as they did before the Soviet Union collapsed. They're still short of meat, and the milk supply remains a real problem, but their caloric intake has returned to normal: they've gotten that meal back.

In so doing, Cubans have created what may be the world's largest working model of a semisustainable agriculture, one that relies far less than the rest of the world does on oil, on chemicals, on shipping vast quantities of food back and forth. They import some of their food—a certain amount of rice from Vietnam, even some apples and beef from the United States, since farm-state senators have weakened our embargo. But mostly they grow their own.

Consider Villa Alamar, for instance, a planned community built outside Havana at the height of the Soviet glory days. Its crumbling, precast-concrete apartments would look at home (though less mildewed) in Ljubljana or Omsk. Even the names there speak of the past: a central square is called Parque Hanoi, to commemorate the "Vietnamese liberation struggle." But right next to Parque Hanoi is the Vivero Organopónico Alamar.

Cuba has thousands of *organopónicos*—urban gardens—more than two hundred in the Havana area alone. The Vivero Organopónico Alamar is especially beautiful: a few acres of vegetables attached to a shady yard packed with potted plants for sale, birds in wicker cages, a cafeteria, and a small market where a steady stream of local people buys tomatoes, lettuce,