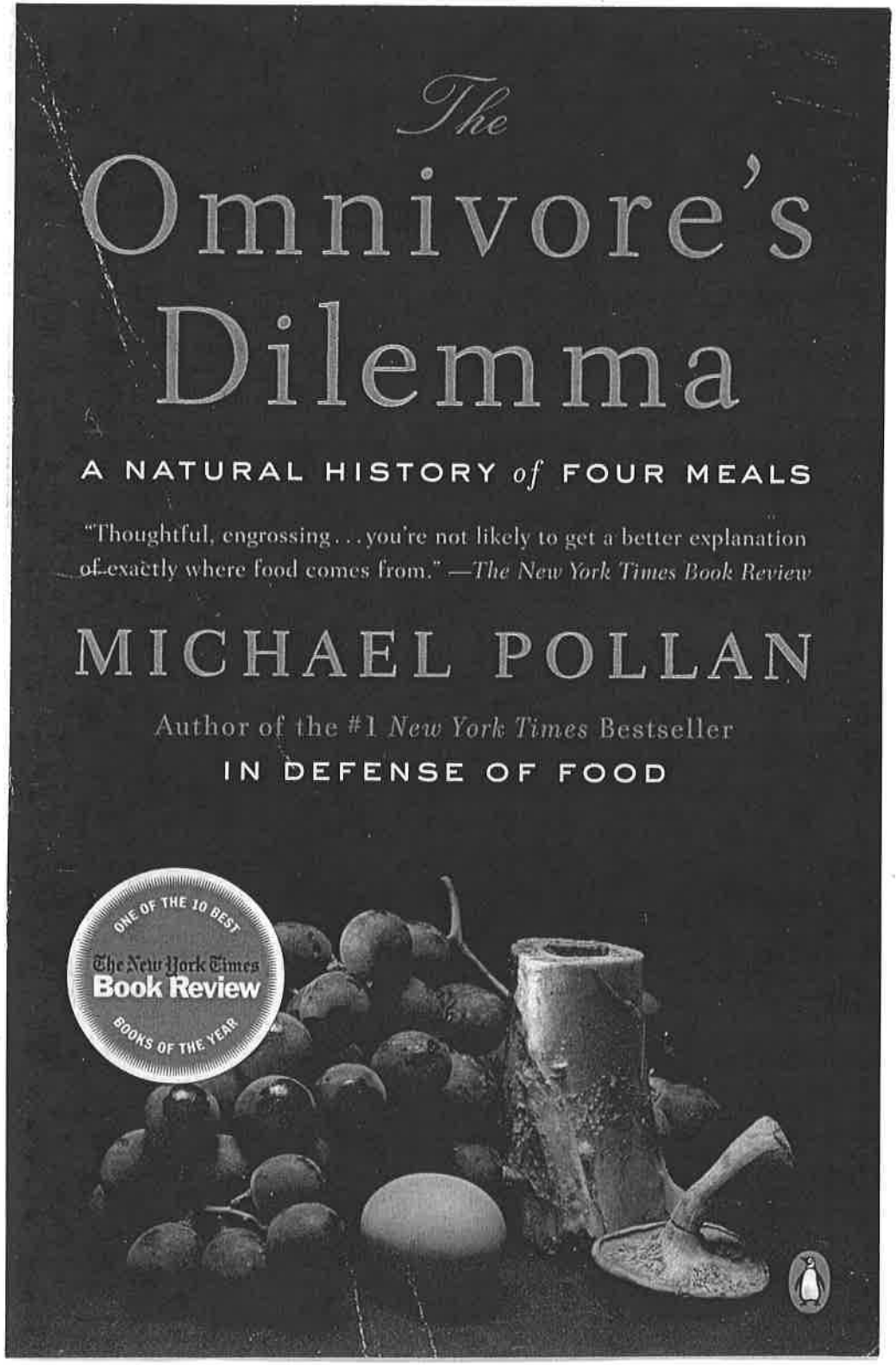

TEN

GRASS

Thirteen Ways of Looking at a Pasture

1. MONDAY

For something people profess to like so much, grass is peculiarly hard for us to see. Oh, you can see it well enough in a general sense, but how much do you *really* see when you look at a patch of grass? The color green, of course, perhaps a transitory recording of the breeze: an abstraction. Grass to us is more ground than figure, a backdrop to more legible things in the landscape—trees, animals, buildings. It's less a subject in its own right than a context. Maybe this has to do with the disparity in scale between us and the uncountable tiny beings that make up a pasture. Maybe we're just too big to see what's going on down there in any detail.

Curiously, we seem to like grass less for what it is than for what it isn't—the forest, I mean—and yet we're much more likely to identify with a tree than a blade of grass. When poets liken people to blades of grass it's usually to humble us, to pull the rug out from under our individuality and remind us of our existential puniness. Composed of so

many tiny seemingly indistinguishable parts, a patch of grass—which on closer inspection isn't even composed of grasses half the time but of legumes and broad-leafed plants of many kinds—resolves itself in our perception into an undifferentiated mass, a more or less shaggy field of color. This way of looking at, or not looking at, grass must suit us, or why would we work so hard to keep it mowed? Mowing only adds to the abstractness of grass.

This is not at all how grass looks to a cow or for that matter to a grass farmer like Joel Salatin. When one of his cows moves into a new paddock, she doesn't just see the color green; she doesn't even see grass. She sees, out of the corner of her eye, this nice tuft of white clover, the emerald-green one over there with the heart-shaped leaves, or, up ahead, that grassy spray of bluish fescue tightly cinched at ground level. These two entities are as different in her mind as vanilla ice cream is from cauliflower, two dishes you would never conflate just because they both happen to be white. The cow opens her meaty wet lips, curls her sandpaper tongue around the bunched clover like a fat rope, and with the pleasing sound of tearing foliage, rips the mouthful of tender leaves from its crown. She'll get to the fescue eventually, and the orchard grass, and even to quite a few of the weeds, but not before she's eaten all the clover ice cream she can find.

Joel calls his pastures the "salad bar," and to his cows they contain at least as many different things to eat. As well as a few things not to eat. Though we might fail to notice the handful of Carolina nightshades or thistles lurking in this pasture, when the cows are done grazing it tomorrow, those plants will still be standing, like forlorn florets of cauliflower languishing on a picky child's plate.

What watching this cow eat her supper tells me is that the scale argument doesn't really hold. The reason we don't see very much when we look at grass has less to do with our relative proportions than with our interests. The cow I'm following in Joel Salatin's pasture this evening is a far sight bigger than I am, and in most matters a good deal less perceptive, yet she can pick a clump of timothy out of this illegible green chaos in less time than it would take me to remember that plant's

name. I don't eat timothy, or even clover. But if I did I'd probably perceive the order and beauty and delectability of this salad bar as vividly as she does. Legibility, too, is in the eye of the beholder.

Joel doesn't eat grass either—it's one of the few nutritious things in nature the human omnivore, lacking a rumen to break down its cellulose, can't digest—yet he can see the salad bar almost as vividly as his cows. That first day I spent on his farm, when he insisted that before I met any animals I join him down on his belly in a pasture, he introduced me to orchard grass and fescue, to red and white clover, to millet and bluegrass, plantain and timothy and sweet grass, which he pulled a blade of for me to taste (and a very sweet grass it is). Joel wanted me to understand why he calls himself a grass farmer rather than a rancher or a pig farmer or a chicken farmer or a turkey farmer or a rabbit farmer or an egg farmer. The animals come and go, but the grasses, which directly or indirectly feed all the animals, abide, and the well-being of the farm depends more than anything else on the well-being of its grass.

Grass farming is a relatively new term in American agriculture, imported from New Zealand by Allan Nation, the editor of *Stockman Grass Farmer*, in the 1980s. *Stockman* is a tabloid monthly, chock-full of ads for portable electric fencing, mineral supplements, and bull semen, that has become the bible for the growing band of livestock producers who practice something called "management-intensive grazing," or as abbreviated in the pages of Nation's magazine, MiG. (It's sometimes also called rotational grazing.) Joel writes a column for the *Stockman Grass Farmer* called The Pastoralist, and has become close friends with Nation, whom he regards as something of a mentor.

When Allan Nation went to New Zealand in 1984 and heard sheep ranchers there refer to themselves as grass farmers something clicked, he says, and he began to regard the growing of food in a completely fresh light. Nation promptly changed the name of his little journal from the *Stockman* to *Stockman Grass Farmer* and "got pretty evangelical about grass." He gathered around his magazine a group of like-minded grass evangelists, including Joel, Jim Gerrish, an Idaho rancher and

teacher (who coined the phrase "management-intensive grazing"), Gerald Fry, a breeding specialist, Jo Robinson, a health writer who studies the health benefits of grass-fed meat, and an Argentine agronomist named Dr. Anibal Pordomingo. Many of these people first encountered the theory of rotational grazing in the work of André Voisin, a French agronomist whose 1959 treatise, *Grass Productivity*, documented that simply by applying the right number of ruminants at the right time pastures could produce far more grass (and, in turn, meat and milk) than anyone had ever thought possible.

Grass farmers grow animals—for meat, eggs, milk, and wool—but regard them as part of a food chain in which grass is the keystone species, the nexus between the solar energy that powers every food chain and the animals we eat. "To be even more accurate," Joel has said, "we should call ourselves sun farmers. The grass is just the way we capture the solar energy." One of the principles of modern grass farming is that to the greatest extent possible farmers should rely on the contemporary energy of the sun, as captured every day by photosynthesis, instead of the fossilized sun energy contained in petroleum.

For Allan Nation, who grew up on a cattle ranch in Mississippi, doing so is as much a matter of sound economics as environmental virtue. "All agriculture is at its heart a business of capturing free solar energy in a food product that can then be turned into high-value human energy," he recently wrote in his column, Al's Obs; here each month he applies the theories of a decidedly eclectic group of thinkers (ranging from business gurus like Peter Drucker and Michael Porter to writers like Arthur Koestler) to the problems of farming. "There are only two efficient ways to do this," he wrote in his column. "One is for you to walk out in your garden, pull a carrot and eat it. This is a direct transfer of solar energy to human energy. The second most efficient way is for you to send an animal out to gather this free solar food and then you eat the animal.

"All other methods of harvest and transfer require higher capital and petroleum energy inputs and these necessarily lower the return to the farmer/rancher. As Florida rancher Bud Adams once told me, 'Ranching is a very simple business. The really hard part is keeping it simple.'"

The simplest way to capture the sun's energy in a form food animals can use is by growing grass: "These blades are our photovoltaic panels," Joel says. And the most efficient—if not the simplest—way to grow vast quantities of solar panels is by management-intensive grazing, a method that as its name implies relies more heavily on the farmer's brain than on capital—or on energy-intensive inputs. All you need, in fact, is some portable electric fencing, a willingness to move your livestock onto fresh pasture every day, and the kind of intimate knowledge of grass that Joel tried to impart to me that early spring afternoon, down on our bellies in his pasture.

"The important thing to know about any grass is that its growth follows a sigmoid, or S, curve," Joel explained. He grabbed my pen and notebook and began drawing a graph, based on one that appears in Voisin's book. "This vertical axis here is the height of our grass plant, okay? And the horizontal axis is time: the number of days since this paddock was last grazed." He started tracing a big S on the page, beginning in the lower left-hand corner where the two axes met. "See, the growth starts out real slow like this, but then after a few days it begins to zoom. That's called 'the blaze of growth,' when the grass has recovered from the first bite, rebuilt its reserves and root mass, and really taken off. But after a while"—the curve leveled out at around day fourteen or so—"it slows down again, as the grass gets ready to flower and seed. It's entering its period of senescence, when the grass begins to lignify [get woody] and becomes less palatable to the cow.

"What you want to do is graze a pasture right at this point here"—he tapped my pad sharply—"at the very top of the blaze of growth. But what you never, ever want to do is violate the law of the second bite. You can't let your cows take a second bite of a grass before it has had a chance to fully recover."

If the law of the second bite were actually on the books, most of the world's ranchers and dairy farmers would be outlaws, since they allow their stock to graze their pastures continuously. By allowing cattle a sec-

ond or third bite, the most desirable "ice cream" species—clover, orchard grass, sweet grass, bluegrass, timothy—weaken and gradually disappear from the sward, giving way to bald spots and to weedy and brushy species the cows won't touch. Any plant wants to keep its roots and shoots roughly in balance, so grasses kept short by overgrazing lack the deep roots needed to bring water and minerals up from the subsoil. Over time a closely cropped grassland deteriorates, and in a dry or brittle environment, it will eventually turn into a desert. The reason environmentalists in the western United States take such a dim view of grazing is that most ranchers practice continuous grazing, degrading the land by flouting the law of the second bite.

Joel pulled a single blade of orchard grass, showing me exactly where a cow had sheared it the week before, and pointing out the finger of fresh green growth that had emerged from the cut in the days since. The blade was a kind of timeline, sharply demarcated between the dark growth predating the bite, and the bright green blade coming after it. "That's the blaze of growth, right there. I'd say this paddock will be ready for the cows to come back in three or four more days."

"Management intensive" it is. Joel is constantly updating the spreadsheet he keeps in his head to track the precise stage of growth of the farm's several dozen paddocks, which range in size from one to five acres, depending on the season and the weather. This particular paddock, a flattish five acres directly behind the barn that is bordered to the north by a hedgerow and to the south by the creek and dirt road that links Polyface's various parts and pastures like a crooked tree trunk, now took its place on the mental schedule. The sheer number of local variables involved in making such a determination hurt my head to consider, and help explain the difficulty of fitting intensive grazing into an industrial agriculture founded on standardization and simplicity. The amount of time it takes a paddock to recover is constantly changing, depending on temperature, rainfall, exposure to the sun, and the time of year, as does the amount of forage any given cow requires, depending on its size, age, and stage of life: A lactating cow, for example, eats twice as much grass as a dry one.

The unit in which a grass farmer performs and records all these calculations, deciding exactly when and where to move the herd, is a "cow day," which is simply the average amount of forage a cow will eat in one day; for his rotations to work, the farmer needs to know just how many cow days each paddock will yield. Though it turns out that, as a unit of measurement a cow day is a good deal more rubbery than, say, the speed of light, since the number of cow days any given paddock can supply rises and falls in response to all the aforementioned variables.

As destructive as overgrazing can be to a pasture, undergrazing can be almost as damaging, since it leads to woody, senescent grasses and a loss of productivity. But getting it just right—grazing the optimal number of cattle at the optimal moment to exploit the blaze of growth—yields tremendous amounts of grass, all the while improving the quality of the land. Joel calls this optimal grazing rhythm "pulsing the pastures" and says that at Polyface it has boosted the number of cow days to as much as four hundred per acre; the county average is seventy. "In effect we've bought a whole new farm for the price of some portable fencing and a lot of management."

Grass farming done well depends almost entirely on a wealth of nuanced local knowledge at a time when most of the rest of agriculture has come to rely on precisely the opposite: on the off-farm brain, and the one-size-fits-all universal intelligence represented by agrochemicals and machines. Very much on his own in a very particular place, the grass farmer must continually juggle the various elements of his farm in space as well as time, relying on his powers of observation and organization to arrange the appointed daily meeting of animal and grass in such a way as to ensure maximum benefit for both.

So is this sort of low-tech pastoralism simply a throwback to preindustrial agriculture? Salatin adamantly begged to differ: "It might not look that way, but this is all information-age stuff we're doing here. Polyface Farm is a postindustrial enterprise. You'll see."

2. MONDAY EVENING

As I neared the blessed, longed-for end of my first day as a Polyface farmhand, I must say I didn't feel at all the way I normally do after a day spent laboring in the information economy. And there was still one more daunting chore before dinner: moving the cows, an operation that, Joel wanted me to understand, is a whole lot easier than it sounds. I certainly hoped so. Throwing and stacking fifty-pound bales of hay all afternoon had left me bone tired, sore, and itchy all over from pricks of the chaff, so I was mightily relieved when Joel proposed we ride the four-wheeler to the upper pasture where the cows had spent their day. (It's axiomatic that the more weary you feel the more kindly you look on fossil fuel.) We stopped by the toolshed for a freshly charged car battery to power the electrified paddock fence, and sped up the rutted dirt road, Joel behind the wheel, me hanging on behind him, trying to keep my rear end planted on the little wooden deck he'd rigged up for hauling stuff around the farm.

"My neighbors think I'm insane, moving my cows as often as I do. That's because when most people hear the words 'moving the cattle' they picture a long miserable day, featuring a couple of pickup trucks, a bunch of barking dogs, several cans of Skoal, and a whole lot of hollering," Joel said, hollering himself to be heard over the ATV's engine. "But honestly, it's not like that at all."

Like most grass farmers who practice rotational grazing, Joel moves his cattle onto fresh grass every day. The basic principle is "mob and move," he explained, as we bumped to a halt at the gate to the upper pasture. Eighty or so cattle were milling or lying around what looked like relatively tight quarters in a fenced-off section of a much larger pasture that sloped to the south.

"What we're trying to do here is mimic on a domestic scale what herbivore populations do all over the world. Whether it is wildebeests on the Serengeti, caribou in Alaska, or bison on the American plains,

multistomached herds are always moving onto fresh ground, following the cycles of the grass. Predators forced the buffalo to move frequently, and stay mobbed-up together for safety."

These intense but brief stays completely change the animals' interaction with the grass and the soil. They eat down just about everything in the paddock, and then they move on, giving the grasses a chance to recover. Native grasses evolved to thrive under precisely such grazing patterns; indeed, they depend on them for their reproductive success. Not only do ruminants spread and fertilize seed with their manure, but their hoofprints create shady little pockets of exposed soil where water collects—ideal conditions for germinating a grass seed. And in brittle lands during the driest summer months, when microbial life in the soil all but stops, the rumen of the animals takes over the soil's nutrient-cycling role, breaking down dry plant matter into basic nutrients and organic matter, which the animals then spread in their urine and manure.

The mob-and-move routine also helps to keep the ruminants healthy. "Short-duration stays allow the animals to follow their instinct to seek fresh ground that hasn't been fouled by their own droppings, which are incubators for parasites."

Joel disconnected the electric fence from its battery and held down the wire with his boot to let me into the paddock. "We achieve the same objective domestically with our portable electric fences. The fence plays the role of predator in our system, keeping the animals mobbed up and making it possible for us to move them every day." The technology for this light, inexpensive electric fencing (elements of which Joel's father invented in the 1960s) was the breakthrough that made management-intensive grazing practical. (Though much earlier, dogs allowed shepherds to practice a rough approximation of rotational grazing.)

Clearly Joel's cattle knew the drill; I could feel their anticipation. Cows that had been lying around roused themselves, and the bolder ones slowly lumbered over in our direction, one of them—"That's Budger"—stepping right up to nuzzle us like a big cat. Joel's herd is an exceptionally amiable if somewhat motley crew of black, brown, and

yellowish animals, crosses of Brahman, Angus, and shorthorn bloodlines. He doesn't believe in artificial insemination or put much stock in fancy genetics. Instead he picks a new bull from his crop of calves every couple of years, naming him for a celebrated Lothario: Slick Willie had the job for much of the Clinton administration. You wouldn't mistake Slick's progeny for show cattle, yet their coats were sleek, their tails were clean, and for cows on a steamy afternoon in June, they had remarkably few flies on them.

It took the two of us working together no more than fifteen minutes to fence a new paddock next to the old one, drag the watering tub into it, and set up the water line. (The farm's irrigation system is gravity-fed from a series of ponds Joel's dug on the hillside.) The grasses in the new paddock were thigh-high and lush, and the cattle plainly couldn't wait to get at them.

The moment arrived. Looking more like a maître d' than a rancher, Joel opened the gate between the two paddocks, removed his straw hat and swept it grandly in the direction of the fresh salad bar, and called his cows to their dinner. After a moment of bovine hesitation, the cows began to move, first singly, then two by two, and then all eighty of them sauntered into the new pasture, brushing past us as they looked about intently for their favorite grasses. The animals fanned out in the new paddock and lowered their great heads, and the evening air filled with the muffled sounds of smacking lips, tearing grass, and the low snuffling of contented cows.

The last time I had stood watching a herd of cattle eat their supper I was standing up to my ankles in cow manure in Poky Feeders pen number 43 in Garden City, Kansas. The difference between these two bovine dining scenes could not have been starker. The single most obvious difference was that these cows were harvesting their own feed instead of waiting for a dump truck to deliver a total mixed ration of corn that had been grown hundreds of miles away and then blended by animal nutritionists with urea, antibiotics, minerals, and the fat of other cattle in a feedlot laboratory. Here we'd brought the cattle to the food rather than the other way around, and at the end of their meal there'd

be nothing left for us to clean up, since the cattle would spread their waste exactly where it would do the most good.

Cows eating grasses that had themselves eaten the sun: The food chain at work in this pasture could not be any shorter or simpler. Especially when I compared it to the food chain passing through the feedlot, with its transcontinental tentacles reaching all the way back to cornfields in Iowa, from there to the hypoxic zone in the Gulf of Mexico, and farther still, to the oil fields of the Persian Gulf that had supplied much of the energy to grow the corn. The flaked number 2 corn in steer 534's feed bunk linked him to an industrial (not to mention military) complex that reached halfway around the world.

And yet if I could actually see everything that was going on right here in this pasture, could trace all the ecological connections involved, the scene unfolding directly before me was not nearly as simple as it looked. In fact, there was easily as much complexity present in a single square foot of this pasture as there is in the whole industrial complex into which 534 was plugged; what makes this pasture's complexity so much harder for us to comprehend is that it is not a complexity of our making.

But try anyway. Focus in for a moment on just the relationship between Budger and the tuft of fescue she's tearing from its crown. Those blades of grass have spent this long June day turning sunlight into sugars. (The reason Joel moves his cattle at the end of the day is because that's when sugar levels in the grass hit their peak; overnight the plant will gradually use up these reserves.) To feed the photosynthetic process the grass's roots have drawn water and minerals up from deep in the soil (some grasses can sink their roots as much as six feet down), minerals that soon will become part of this cow. Chances are Budger has also chosen exactly which grasses to eat first, depending on whatever minerals her body craves that day; some species supply her more magnesium, others more potassium. (If she's feeling ill she might go for the plantain, a forb whose leaves contain antibiotic compounds; grazing cattle instinctively use the diversity of the salad bar to medicate themselves.) By contrast 534, who never got to pick and choose his dinner,

let alone his medications, depends on animal nutritionists to design his total ration—which of course is only as total as the current state of knowledge in animal science permits.

So far the relationship between Budger and this square foot of pasture might seem a little one-sided, since viewed at least from where I stood, Budger's bite appears to have diminished the pasture. But if I could view the same event from underground and over time, I would see that that bite is not a zero-sum transaction between cow and grass plant. The moment Budger shears the clump of grass, she sets into motion a sequence of events that will confer a measurable benefit on this square foot of pasture. The shorn grass plant, endeavoring to restore the rough balance between its roots and leaves, will proceed to shed as much root mass as it's just lost in leaf mass. When the discarded roots die, the soil's resident population of bacteria, fungi, and earthworms will get to work breaking them down into rich brown humus. What had been the grass plant's root runs will become channels through which worms, air, and rainwater will move through the earth, stimulating the process by which new topsoil is formed.

It is in this manner that the grazing of ruminants, when managed properly, actually builds new soil from the bottom up. Organic matter in a pasture also builds from the top down, as leaf litter and animal wastes break down on the surface, much as it does on a forest floor. But in a grassland decaying roots are the biggest source of new organic matter, and in the absence of grazers the soil-building process would be nowhere near as swift or productive.

Back up to the surface now. Over the next few days, Budger's shearing of this grass plant will stimulate new growth, as the crown redirects reserves of carbohydrate energy from the roots upward to form new shoots. This is the critical moment when a second bite would derail the grass's recovery, since the plant has to live on these reserves until it has grown new leaves and resumed photosynthesis. As the plant adds leaves it adds new roots too, reaching deeper into the soil, making good use of the humus the first bite helped sponsor, and bringing nutrients up to the surface. Over the course of the season this one grass plant will convert more sunlight into more biomass, both above and below the surface of the pasture, than it ever would have had it never encountered a cow.

Yet it's misleading to speak about any grass plant in isolation, since many different plant species, performing many different functions, occupy even this one square foot of pasture, and Budger's bite subtly alters the composition of this community. The shearing of the tallest grasses exposes the pasture's shorter plants to sunlight, stimulating their growth. This is why a well-grazed pasture will see its population of ground-hugging clovers increase, a boon to grasses and grazers alike. These legumes fix nitrogen in the soil, fertilizing the neighboring grasses from below while supplying nitrogen to the grazers above; the bacteria living in the animal's rumen will use the nitrogen in these clover leaves to construct new molecules of protein.

Side-by-side comparisons of intensive and continuously grazed pastures have demonstrated that intensive grazing increases the diversity of species in pastures. That's because rotated cattle don't eliminate favored species by overgrazing them and their equal-opportunity shearing ensures that no one species of grass ever dominates by rising to hog all the sunlight. This biodiversity confers a great many benefits on all parties. At the most fundamental level, it allows the farm's land to capture the maximum amount of solar energy, since one kind of photosynthesizer or another is occupying every conceivable niche—niches in space as well as time. For example, when the early season grasses slow down in June, the late season grasses step in, and when drought hits, the deep-rooted species will take over from the shallower ones. A diverse enough polyculture of grasses can withstand virtually any shock and in some places will produce in a year nearly as much total biomass as a forest receiving the same amount of rainfall.

This productivity means Joel's pastures will, like his woodlots, remove thousands of pounds of carbon from the atmosphere each year; instead of sequestering all that carbon in trees, however, grasslands store most of it underground, in the form of soil humus. In fact, grassing over that portion of the world's cropland now being used to grow

grain to feed ruminants would offset fossil fuel emissions appreciably. For example, if the sixteen million acres now being used to grow corn to feed cows in the United States became well-managed pasture, that would remove fourteen billion pounds of carbon from the atmosphere each year, the equivalent of taking four million cars off the road. We seldom focus on farming's role in global warming, but as much as a third of all the greenhouse gases that human activity has added to the atmosphere can be attributed to the saw and the plow.

The benefits of a food chain rooted in a perennial polyculture are so many and so great that they've inspired dreams of converting our agriculture of annual grains into something that would look a lot more like Joel Salatin's pastures. That particular vision hatched more than thirty years ago in the mind of a graduate student in plant genetics named Wes Jackson. Today breeders at his Land Institute, in Salina, Kansas, are working on a (very) long-term project to "perennialize" many of our principal grain crops (including corn) and then grow them in polycultures that farmers would seldom if ever have to plow or replant. The basic idea is to allow us to live off the land (and the sun) more like ruminants do, by coaxing perennial grasses (which we can't digest) to yield bigger and more nutritious seeds (which we can). Of course, the same goal would be accomplished by changing us rather than the grasses—giving people rumens, that is, so they could digest grasses. And there are skeptics who believe perennializing the major crops is no less of a pipe dream than outfitting humans with rumens. Jackson claims his group is making slow but steady progress, however, and has already disproved the conventional wisdom, widely held among botanists, that plants must choose, in effect, between devoting their energy to the production of seeds, as annuals do, or using it to survive the winter in the manner of perennials.

For the time being, though, I'll have to eat Budger herself if I want to make use of the food energy contained in the grasses growing in Joel Salatin's pastures. For me, Wes Jackson's audacious vision of an agriculture that might someday feed us without diminishing the earth's substance (its soil), as even the most sustainable annual agriculture must do, only deepens my appreciation for the grass-based food chain we already have—the one, I mean, that links Budger to the soil and sun and, eventually, to me. It's true that prodigious amounts of food energy are wasted every time an animal eats another animal—nine calories for every one we consume. But if all that energy has been drawn from the boundless storehouse of the sun, as in the case of eating meat off this pasture, that meal comes as close to a free lunch as we can hope to get. Instead of mining the soil, such a meal builds more of it. Instead of diminishing the world, it has added to it.

ALL OF WHICH begs a rather large question: Why did we ever turn away from this free lunch in favor of a biologically ruinous meal based on corn? Why in the world did Americans ever take ruminants off the grass? And how could it come to pass that a fast-food burger produced from corn and fossil fuel actually costs less than a burger produced from grass and sunlight?

I asked myself these questions standing there in Joel's pasture that evening, and in the months since I've thought of several answers. The most obvious answer turns out not to be true. I had thought that the victory of corn over grass might owe to the fact that a field of corn simply produces more total food energy than an acre of grass; it certainly looks that way. But researchers at the Land Institute have studied this question and calculated that in fact more nutrients are produced—protein and carbohydrate—in an acre of well-managed pasture than in an acre of field corn. How can this be? Because a polyculture of grass, with its wide diversity of photosynthesizers exploiting every inch of land as well as every moment of growing season, captures more solar energy and therefore produces more biomass than a cornfield; also, only the kernels are harvested from a cornfield, whereas virtually all the grass grown in a pasture finds its way into the rumen.

Even so, the temptations of cheap corn are powerful, as irresistible

as the temptations of cheap energy. Even before the advent of the feedlot, farmers had begun using a little corn to finish their cattle—fatten them for slaughter—whenever they ran out of good grass, especially in the fall and winter. "When you're trying to finish cattle," Allan Nation pointed out, "corn covers a multitude of sins." Cattlemen found that corn, being such a dense source of calories, produced meat more quickly than grass; it also produced a more reliably consistent product, eliminating the seasonal and regional differences you often find in grass-finished beef. Over time, the knowledge that went into growing grass good enough to finish cattle all the year round gradually was lost.

Along the way corn kept getting more plentiful and ever cheaper. When the farmer found that he could buy corn more cheaply than he could ever hope to grow it, it no longer made economic sense to feed animals on the farm, so they moved into CAFOs. The farmer who then plowed up his pastures to grow corn to market found he could take off to Florida in the winter, not work so hard. To help dispose of the rising mountain of cheap corn farmers were now producing, the government did everything it could to help wean cattle off grass and onto corn, by subsidizing the building of feedlots (through tax breaks) and promoting a grading system based on marbling that favored corn-fed over grass-fed beef. (The government also declined to make CAFOs obey clean air and clean water laws.) In time the cattle themselves changed, as the industry selected for animals that did well on corn; these animals, generally much bigger, had trouble getting all the energy they needed from grass. In dairy, farmers moved to superproductive breeds like the Holstein, whose energy requirements were so great they could barely survive on a diet of grass.

So feeding ruminants corn came to make a certain economic sense—I say "certain" because that statement depends on the particular method of accounting our economy applies to such questions, one that tends to hide the high cost of cheap food produced from corn. The ninety-nine-cent price of a fast-food hamburger simply doesn't take account of that meal's true cost—to soil, oil, public health, the public purse, etc., costs which are never charged directly to the consumer but, indirectly and

invisibly, to the taxpayer (in the form of subsidies), the health care system (in the form of food-borne illnesses and obesity), and the environment (in the form of pollution), not to mention the welfare of the workers in the feedlot and the slaughterhouse and the welfare of the animals themselves. If not for this sort of blind-man's accounting, grass would make a lot more sense than it now does.

So there are a great many reasons American cattle came off the grass and into the feedlot, and yet all of them finally come down to the same one: Our civilization and, increasingly, our food system are strictly organized on industrial lines. They prize consistency, mechanization, predictability, interchangeability, and economies of scale. Everything about corn meshes smoothly with the gears of this great machine; grass doesn't.

Grain is the closest thing in nature to an industrial commodity: storable, portable, fungible, ever the same today as it was yesterday and will be tomorrow. Since it can be accumulated and traded, grain is a form of wealth. It is a weapon, too, as Earl Butz once had the bad taste to mention in public; the nations with the biggest surpluses of grain have always exerted power over the ones in short supply. Throughout history governments have encouraged their farmers to grow more than enough grain, to protect against famine, to free up labor for other purposes, to improve the trade balance, and generally to augment their own power. George Naylor is not far off when he says the real beneficiary of his crop is not America's eaters but its military-industrial complex. In an industrial economy, the growing of grain supports the larger economy: the chemical and biotech industries, the oil industry, Detroit, pharmaceuticals (without which they couldn't keep animals healthy in CAFOs), agribusiness, and the balance of trade. Growing corn helps drive the very industrial complex that drives it. No wonder the government subsidizes it so lavishly.

You cannot say any of these things about grass. The government writes no subsidy checks to grass farmers. Grass farmers, who buy little in the way of pesticides and fertilizers (none, in the case of Joel Salatin), do little to support agribusiness or the pharmaceutical indus-

try or big oil. A surplus of grass does nothing for a nation's power or its balance of payments. Grass is not a commodity. What grass farmers grow can't easily be accumulated, traded, transported, or stored, at least for very long. Its quality is highly variable, different from region to region, season to season, even farm to farm; there is no number 2 hay. Unlike grain, grass can't be broken down into its constituent molecules and reassembled as value-added processed foods; meat, milk, and fiber is about all you can make out of grass, and the only way to do that is with a living organism, not a machine. Grass farming with skill involves so many variables, and so much local knowledge, that it is difficult to systematize. As faithful to the logic of biology as a carefully grazed pasture is, it meshes poorly with the logic of industry, which has no use for anything it cannot bend to its wheels and bottom line. And, at least for the time being, it is the logic of industry that rules.

3. MONDAY SUPPER

Once the cows were settled in their paddock for the night, Joel showed me how to hook the electric fence to its battery and we rolled down the hill to dinner. We ditched our boots by the back door, washed up in a basin in the mudroom, and sat down to a meal prepared by Joel's wife, Teresa, and Rachel, the Salatins' eighteen-year-old daughter. The farm's two young interns, Galen and Peter, joined us at the big pine table, and focused so intently on eating they uttered not a word. The Salatins' son Daniel, twenty-two, is a full partner in the farm, but most nights he has dinner with his wife and baby son in the new house they recently built themselves, up the hill. Joel's mother, Lucille, also lives on the property, in a trailer home next to the house. It was in Lucille's guest room that I was sleeping.

The Salatins' brick colonial dates to the eighteenth century, and my first impression of the big, cozy kitchen was that it looked strangely familiar. Then it dawned on me: This is exactly the sort of farmhouse kitchen—wood-paneled and decorated with all things quaint and hearth-

like, up to and including the neatly framed needlepoints—that countless kitchens in American suburbs and sitcoms have been striving to simulate at least since World War II. This was what all that nostalgia pointed to, the real McCoy.

Indeed, much about dining with the Salatins had, at least for me, the flavor of a long-ago time and faraway place in America. Joel began the meal by closing his eyes and saying a rambling and strikingly nongeneric version of grace, offering a fairly detailed summary of the day's doings to a Lord who, to judge by Joel's tone of easy familiarity, was present and keenly interested. Everything we ate had been grown on the farm, with the exception of the cream of mushroom soup that tied together Teresa's tasty casserole of Polyface chicken and broccoli from the garden. Rachel passed a big platter of delicious deviled eggs, eggs that in this form or some other would appear at every meal that week. Though it wasn't even the end of June, we tasted the first sweet corn of the season, which had been grown in the hoop house where the laying hens spend the winter. There was plenty of everything, and the interns endured many jokes about their stupendous appetites. To drink there was only a pitcher of ice water. Caffeine and alcohol, both of which I sorely felt the need of at the end of my first day, were nowhere in evidence. It was going to be a long week.

At dinner I mentioned that this was probably the all-time most local meal I'd ever eaten. Teresa joked that if Joel and Daniel could just figure out how to mill paper towels and toilet paper from the trees on the farm, she'd never have to go to the supermarket. It was true: We were eating almost completely off the grid. I realized that the sort of agriculture practiced at Polyface was very much of a piece with the sort of life the Salatins led. They had largely detached their household from industrial civilization, and not just by eating from land that had virtually no economic or ecological ties to what Joel variously called "the empire," "the establishment," and "Wall Street." Joel, who had described his politics as Christian libertarian environmentalist, wanted nothing to do with "institutional anything," but especially the institutions of government. Daniel and Rachel had both been homeschooled.

There were plenty of books in the house, but, aside from the Staunton daily newspaper, which devoted more space to local car crashes than the war in Iraq, little media (and no television) penetrated the Salatin household.

The farm and the family comprised a remarkably self-contained world, in the way I imagined all American farm life once did. But the agrarian self-sufficiency that Thomas Jefferson celebrated used to be a matter of course and a product of necessity; nowadays that sort of independence constitutes a politics and economics and way of life both deliberate and hard-won—an achievement. Were Jefferson to return today he would no doubt be gratified to learn that there were still farmers down the road from Monticello as Jeffersonian as Joel Salatin. Until, that is, Jefferson got around a bit more and discovered there weren't many others like him.

At dinner I got Joel and Teresa talking about the history of Polyface, a history in which the roots of Salatin's politics and agriculture become fairly easy to trace. "I'm actually a third-generation alternative farmer," Joel said. "My grandfather was a charter subscriber to Rodale's *Organic Gardening and Farming*." Fred Salatin had farmed a half-acre in-town lot in Anderson, Indiana, supplying the local markets with fruit, honey, and eggs sold in boxes that bore the Salatin name. Fred Salatin, who was as much an inventor and tinkerer as he was a farmer, held the patent for the very first walking garden sprinkler.

To hear Joel and Teresa describe him, Joel's father William was an ingenious and somewhat eccentric farmer, a man who wore bow ties and sandals and drove a '58 Plymouth sedan that he'd converted into a pickup by removing all the seats and the lid of the trunk. ("He would drive it into town sitting on a bucket," Joel explained. "It embarrassed us kids terribly.") From the time he was a young boy, William had wanted to farm; after flying planes in World War II and earning an economics degree from Indiana University, he bought a farm in the highlands of Venezuela, where he and Lucille began raising chickens. Why Venezuela? "Dad felt he could farm the way he wanted there, get out from under both convention and regulations."

The chicken farm thrived until 1959, when a leftist coup toppled the government and "we got caught as ugly Americans in the middle of this political mess." Joel's father refused on principle to buy protection from the local authorities, who proceeded to look the other way when guerillas came after the family's property. "We fled out the back door as the guerillas were coming in the front. We stayed in the country nine or ten months after that, living with a missionary friend while my dad tried to get the government to return our land. We had a deed, but not a single official would look at us without a bribe. And the whole time the American ambassador was dutifully reporting that everything was under control."

In 1961 the Salatins were forced to flee the country, leaving behind everything they'd built and saved. "Now that I'm hitting the age he was then, I just can't imagine what it must have felt like to walk away from it all." The episode clearly left its mark on Joel, undermining his faith that a government, right or left, could protect its citizens and their property, much less do the morally right thing.

Determined to start over again, William Salatin went shopping for farmland within a day's drive of Washington, D.C., so that he might continue petitioning the Venezuelan embassy for compensation. He ended up buying 550 acres of badly eroded and hilly farmland on the western edge of the Shenandoah Valley, in the tiny town of Swoope. (It's pronounced Swope.) After Drew Pearson, the muckraking journalist, publicized his case against the Venezuelans, Salatin won a small settlement that he used to buy a small herd of Hereford cattle.

"The farm had been abused by tenant farmers for 150 years," Joel said. On land that was really too steep for row crops, several generations of tenant farmers had grown corn and other grains until most of the soil had been either exhausted or lost to erosion. "We measured gullies fourteen feet deep. This farm couldn't stand any more plowing. In many places there was no topsoil left whatsoever—just outcroppings of granite and clay. Some spots you couldn't even dig a posthole, so Dad would fill tires with concrete and sink fence posts in that. We've been working to heal this land ever since."

William Salatin quickly discovered the farm couldn't support both a mortgage and a family, so he took on work in town as an accountant. "He turned the farm into an R&D project instead of a salary project." William was now free to experiment, to turn his back on conventional thinking about how to farm.

His instinct to go against conventional agricultural wisdom was confirmed by his accounting clients, many of whom were struggling farmers. "One look at their books convinced him that all the advice he'd been hearing from consultants and extension agents—to build silos, graze the forest, plant corn, and sell commodities—was a recipe for financial ruin."

"So instead of building bankruptcy tubes"—farmer lingo for silos—"he started down a whole other path." William read André Voisin's treatise on grass and began practicing rotational grazing. He stopped buying fertilizer and started composting. He also let the steeper, north-facing hillsides return to forest.

"Dad was very much a visionary and an inventor. He figured out the key to success on a farm like this was first, grass, and second, mobility." This last guiding principle, which Joel claims goes all the way back to Frederick Salatin's patented walking sprinkler ("moving things must be in our genes"), inspired his father to invent a movable electric fence, a portable veal calf barn, and a portable chicken coop for the laying hens Joel raised as a boy. (Until he went off to college, Joel sold eggs every Saturday at a farmer's market in Staunton.) When William noticed that on hot days the cattle gathered under the trees, concentrating their manure in one place, he built a portable "shademobile"—basically a big section of canvas stretched over a steel frame on wheels. Now he could induce the cattle to spread their manure evenly over his pastures, simply by towing the shademobile to a new spot every few days.

Innovations like these helped rebuild the fertility of the soil, and gradually the farm began to recover. Grasses colonized the gullies, the thin soils deepened, and the rock outcrops disappeared under a fresh mantle of sod. And though William Salatin was never quite able to support his family from the farm, he did live to see Joel make a success of

the place by building on his example, especially the devotion to grass and mobility—and a determination to go his own way. Joel had returned to the farm in 1982 after four years at Bob Jones University and a stint as a newspaper reporter. Six years later, when Joel was thirty-one, William Salatin died of prostate cancer.

"I still miss him every day," Joel said. "Dad was definitely a little odd, but in a good way. How many other Christian conservatives were reading *Mother Earth News*? He lived out his beliefs. I can remember when the Arab oil embargo hit in 1974, Dad rode his bicycle thirty-five miles back and forth to work every day because he refused to buy another drop of imported oil. He would have been a wonderful tent dweller, always living on less than you have and more lightly than you need to." I felt a tiny flush of embarrassment at ever having asked Joel to FedEx me a steak; I also better understood why he had refused.

"But you want to know when I miss him the most? When I see thick hay and earthworm castings and slick cows, all the progress we've made since he left us. Oh, how proud he would be to see this place now!"

ELEVEN

THE ANIMALS

Practicing Complexity

1. TUESDAY MORNING

It's not often I wake up at six in the morning to discover I've overslept, but by the time I had hauled my six-foot self out of the five-foot bed in Lucille's microscopic guest room, everyone was already gone and morning chores were nearly done. Shockingly, chores at Polyface commence as soon as the sun comes up (five-ish this time of year) and always before breakfast. Before coffee, that is, not that there was a drop of it to be had on this farm. I couldn't recall the last time I'd even attempted to do anything consequential before breakfast, or before caffeine at the very least.

When I stepped out of the trailer into the warm early morning mist, I could make out two figures—the interns, probably—moving around up on the broad shoulder of hill to the east, where a phalanx of portable chicken pens formed a checkerboard pattern on the grass. Among other things, morning chores consist of feeding and watering the broilers and moving their pens one length down the hillside. I was

supposed to be helping Galen and Peter do this, so I started up the path, somewhat groggily, hoping to get there before they finished.

As I stumbled up the hill, I was struck by how very beautiful the farm looked in the hazy early light. The thick June grass was silvered with dew, the sequence of bright pastures stepping up the hillside dramatically set off by broad expanses of blackish woods. Birdsong stitched the thick blanket of summer air, pierced now and again by the wood clap of chicken pen doors slamming shut. It was hard to believe this hillside had ever been the gullied wreck Joel had described at dinner, and even harder to believe that farming such a damaged landscape so intensively, rather than just letting it be, could restore it to health and yield this beauty. This is not the environmentalist's standard prescription. But Polyface is proof that people can sometimes do more for the health of a place by cultivating it rather than by leaving it alone.

By the time I reached the pasture Galen and Peter had finished moving the pens. Fortunately they were either too kind or too timid to give me a hard time for oversleeping. I grabbed a pair of water buckets, filled them from the big tub in the center of the pasture, and lugged them to the nearest pen. Fifty of these pens were spread out across the damp grass in a serrated formation that had been calibrated to cover every square foot of this meadow in the course of the fifty-six days it takes a broiler to reach slaughter weight; the pens moved ten feet each day, the length of one pen. Each ten-by-twelve, two-foot-tall floorless pen houses seventy birds. A section of the roof is hinged to allow access, and a five-gallon bucket perched atop each unit feeds a watering device suspended inside.

Directly behind each pen was a perfectly square patch of closely cropped grass resembling a really awful Jackson Pollock painting, thickly spattered with chicken crap in pigments of white, brown, and green. It was amazing what a mess seventy chickens could make in a day. But that was the idea: Give them twenty-four hours to eat the grass and fertilize it with their manure, and then move them onto fresh ground.

Joel developed this novel method for raising broiler chickens in the 1980s and popularized it in his 1993 book, *Pastured Poultry Profit$*, some-

thing of a cult classic among grass farmers. (Joel has self-published four other how-to books on farming, and all but one of them has a $ stepping in for an S somewhere in its title.) Left to their own devices, a confined flock of chickens will eventually destroy any patch of land, by pecking the grass down to its roots and poisoning the soil with its extremely "hot," or nitrogenous, manure. This is why the typical free-range chicken yard quickly winds up bereft of plant life and hard as brick. Moving the birds daily keeps both the land and the birds healthy; the broilers escape their pathogens and the varied diet of greens supplies most of their vitamins and minerals. The birds also get a ration of corn, toasted soybeans, and kelp, which we scooped into long troughs in their pens, but Joel claims the fresh grass, along with the worms, grasshoppers, and crickets they peck out of the grass, provides as much as 20 percent of their diet—a significant savings to the farmer and a boon to the birds. Meanwhile, their manure fertilizes the grass, supplying all the nitrogen it needs. The chief reason Polyface Farm is completely self-sufficient in nitrogen is that a chicken, defecating copiously, pays a visit to virtually every square foot of it at several points during the season. Apart from some greensand (a mineral supplement to replace calcium lost in the meadows), chicken feed is the only important input Joel buys, and the sole off-farm source of fertility. ("The way I look at it, I'm just returning some of the grain that's been extracted from this land over the last 150 years.") The chicken feed not only feeds the broilers but, transformed into chicken crap, feeds the grass that feeds the cows that, as I was about to see, feed the pigs and the laying hens.

After we had finished watering and feeding the broilers, I headed up to the next pasture, where I could hear a tractor idling. Galen had told me Joel was moving the Eggmobile, an operation I'd been eager to watch. The Eggmobile, one of Joel's proudest innovations, is a ramshackle cross between a henhouse and a prairie schooner. Housing four hundred laying hens, this rickety old covered wagon has hinged nesting boxes lined up like saddlebags on either side, allowing someone to retrieve eggs from the outside. I'd first laid eyes on the Eggmobile the night before, parked a couple of paddocks away from the cattle herd.

The hens had already climbed the little ramp into the safety of the coop for the night, and before we went down to dinner Joel had latched the trapdoor behind them. Now it was time to move them into a fresh paddock, and Joel was bolting the Eggmobile to the hitch of his tractor. It wasn't quite 7:00 A.M. yet, but Joel seemed delighted to have someone to talk to, holding forth being one of his greatest pleasures.

"In nature you'll always find birds following herbivores," Joel explained, when I asked him for the theory behind the Eggmobile. "The egret perched on the rhino's nose, the pheasants and turkeys trailing after the bison—that's a symbiotic relationship we're trying to imitate." In each case the birds dine on the insects that would otherwise bother the herbivore; they also pick insect larvae and parasites out of the animal's droppings, breaking the cycle of infestation and disease. "To mimic this symbiosis on a domestic scale, we follow the cattle in their rotation with the Eggmobile. I call these gals our sanitation crew."

Joel climbed onto the tractor, threw it into gear, and slowly towed the rickety contraption fifty yards or so across the meadow to a paddock the cattle had vacated three days earlier. It seems the chickens eschew fresh manure, so he waits three or four days before bringing them in—but not a day longer. That's because the fly larvae in the manure are on a four-day cycle, he explained. "Three days is ideal. That gives the grubs a chance to fatten up nicely, the way the hens like them, but not quite long enough to hatch into flies." The result is prodigious amounts of protein for the hens, the insects supplying as much as a third of their total diet—and making their eggs unusually rich and tasty. By means of this simple little management trick, Joel is able to use his cattle's waste to "grow" large quantities of high-protein chicken feed for free; he says this trims his cost of producing eggs by twenty-five cents per dozen. (Very much his accountant father's son, Joel can tell you the exact economic implication of every synergy on the farm.) The cows further oblige the chickens by shearing the grass; chickens can't navigate in grass more than about six inches tall.

After Joel had maneuvered the Eggmobile into position, he opened the trapdoor, and an eager, gossipy procession of Barred Rocks, Rhode

Island Reds, and New Hampshire Whites filed down the little ramp, fanning out across the pasture. The hens picked at the grasses, especially the clover, but mainly they were all over the cowpats, doing this frantic backward-stepping break-dance with their claws to scratch apart the caked manure and expose the meaty morsels within. Unfolding here before us, I realized, was a most impressive form of alchemy: cowpatties in the process of being transformed into exceptionally tasty eggs.

"I'm convinced an Eggmobile would be worth it even if the chickens never laid a single egg. These birds do a more effective job of sanitizing a pasture than anything human, mechanical, or chemical, and the chickens love doing it." Because of the Eggmobile, Joel doesn't have to run his cattle through a headgate to slather Ivomectrin, a systemic parasiticide, on their hides or worm them with toxic chemicals. This is what Joel means when he says the animals do the real work around here. "I'm just the orchestra conductor, making sure everybody's in the right place at the right time."

THAT DAY, my second on the farm, as Joel introduced me to each of his intricately layered enterprises, I began to understand just how radically different this sort of farming is from the industrial models I'd observed before, whether in an Iowa cornfield or an organic chicken farm in California. Indeed, it is so different that I found Polyface's system difficult to describe to myself in an orderly way. Industrial processes follow a clear, linear, hierarchical logic that is fairly easy to put into words, probably because words follow a similar logic: First this, then that; put this in here, and then out comes that. But the relationship between cows and chickens on this farm (leaving aside for the moment the other creatures and relationships present here) takes the form of a loop rather than a line, and that makes it hard to know where to start, or how to distinguish between causes and effects, subjects and objects.

Is what I'm looking at in this pasture a system for producing exceptionally tasty eggs? If so, then the cattle and their manure are a means to an end. Or is it a system for producing grass-fed beef without the use

of any chemicals, in which case the chickens, by fertilizing and sanitizing the cow pastures, comprise the means to that end? So does that make their eggs a product or a by-product? And is manure—theirs or the cattle's—a waste product or a raw material? (And what should we call the fly larvae?) Depending on the point of view you take—that of the chicken, the cow, or even the grass—the relationship between subject and object, cause and effect, flips.

Joel would say this is precisely the point, and precisely the distinction between a biological and an industrial system. "In an ecological system like this everything's connected to everything else, so you can't change one thing without changing ten other things.

"Take the issue of scale. I could sell a whole lot more chickens and eggs than I do. They're my most profitable items, and the market is telling me to produce more of them. Operating under the industrial paradigm, I could boost production however much I wanted—just buy more chicks and more feed, crank up that machine. But in a biological system you can never do just one thing, and I couldn't add many more chickens without messing up something else.

"Here's an example: This pasture can absorb four hundred units of nitrogen a year. That translates into four visits from the Eggmobile or two passes of a broiler pen. If I ran any more Eggmobiles or broiler pens over it, the chickens would put down more nitrogen than the grass could metabolize. Whatever the grass couldn't absorb would run off, and suddenly I have a pollution problem." Quality would suffer, too: Unless he added more cattle, to produce more grubs for the chickens and to keep the grass short enough for them to eat it, those chickens and eggs would not taste nearly as good as they do.

"It's all connected. This farm is more like an organism than a machine, and like any organism it has its proper scale. A mouse is the size of a mouse for a good reason, and a mouse that was the size of an elephant wouldn't do very well."

Joel likes to quote from an old agricultural textbook he dug out of the stacks at Virginia Tech many years ago. The book, which was published in 1941 by a Cornell Ag professor, offers a stark conclusion that,

depending on your point of view, will sound either hopelessly quaint or arresting in its gnomic wisdom: "Farming is not adapted to large-scale operations because of the following reasons: Farming is concerned with plants and animals that live, grow, and die."

"Efficiency" is the term usually invoked to defend large-scale industrial farms, and it usually refers to the economies of scale that can be achieved by the application of technology and standardization. Yet Joel Salatin's farm makes the case for a very different sort of efficiency—the one found in natural systems, with their coevolutionary relationships and reciprocal loops. For example, in nature there is no such thing as a waste problem, since one creature's waste becomes another creature's lunch. What could be more efficient than turning cow pies into eggs? Or running a half-dozen different production systems—cows, broilers, layers, pigs, turkeys—over the same piece of ground every year?

Most of the efficiencies in an industrial system are achieved through simplification: doing lots of the same thing over and over. In agriculture, this usually means a monoculture of a single animal or crop. In fact, the whole history of agriculture is a progressive history of simplification, as humans reduced the biodiversity of their landscapes to a small handful of chosen species. (Wes Jackson calls our species "homo the homogenizer.") With the industrialization of agriculture, the simplifying process reached its logical extreme—in monoculture. This radical specialization permitted standardization and mechanization, leading to the leaps in efficiency claimed by industrial agriculture. Of course, how you choose to measure efficiency makes all the difference, and industrial agriculture measures it, simply, by the yield of one chosen species per acre of land or farmer.

By contrast, the efficiencies of natural systems flow from complexity and interdependence—by definition the very opposite of simplification. To achieve the efficiency represented by turning cow manure into chicken eggs and producing beef without chemicals you need at least two species (cows and chickens), but actually several more as well,

including the larvae in the manure and the grasses in the pasture and the bacteria in the cows' rumens. To measure the efficiency of such a complex system you need to count not only all the products it produces (meat, chicken, eggs) but also all the costs it eliminates: antibiotics, wormers, parasiticides, and fertilizers.

Polyface Farm is built on the efficiencies that come from mimicking relationships found in nature and layering one farm enterprise over another on the same base of land. In effect, Joel is farming in time as well as in space—in four dimensions rather than three. He calls this intricate layering "stacking" and points out that "it is exactly the model God used in building nature." The idea is not to slavishly imitate nature, but to model a natural ecosystem in all its diversity and interdependence, one where all the species "fully express their physiological distinctiveness." He takes advantage of each species' natural proclivities in a way that benefits not only that animal but other species as well. So instead of treating the chicken as a simple egg or protein machine, Polyface honors—and exploits—"the innate distinctive desires of a chicken," which include pecking in the grass and cleaning up after herbivores. The chickens get to do, and eat, what they evolved to do and eat, and in the process the farmer and his cattle both profit. What is the opposite of zero-sum? I'm not sure, but this is it.

Joel calls each of his stacked farm enterprises a "holon," a word I'd never encountered before. He told me he picked it up from Allan Nation; when I asked Nation about it, he pointed me to Arthur Koestler, who coined the term in *The Ghost in the Machine*. Koestler felt English lacked a word to express the complex relationship of parts and wholes in a biological or social system. A holon (from the Greek *holos*, or whole, and the suffix *on*, as in proton, suggesting a particle) is an entity that from one perspective appears a self-contained whole, and from another a dependent part. A body organ like the liver is a holon; so is an Eggmobile.

At any given time, Polyface has a dozen or more holons up and running, and on my second day Joel and Daniel introduced me to a handful of them. I visited the Raken House, the former toolshed where

Daniel has been raising rabbits for the restaurant trade since he was ten. ("Raken?" "Half rabbit, half chicken," Daniel explained.) When the rabbits aren't out on the pasture in portable hutches, they live in cages suspended over a deep bedding of woodchips, in which I watched several dozen hens avidly pecking away in search of earthworms. Daniel explained that the big problem in raising rabbits indoors is their powerful urine, which produces so much ammonia that it scars their lungs and leaves them vulnerable to infection. To cope with the problem most rabbit farmers add antibiotics to their feed. But the scratching of the hens turns the nitrogenous rabbit pee into the carbonaceous bedding, creating a rich compost teeming with earthworms that feed the hens. Drugs become unnecessary and, considering how many rabbits and chickens lived in it, the air in the Raken was, well, tolerable. "Believe me," Daniel said, "if it weren't for these chickens, you'd be gagging right about now, and your eyes would sting something awful."

Before lunch I helped Galen and Peter move the turkeys, another holon. Moving the turkeys, which happens every three days, means setting up a new "feathernet"—a paddock outlined by portable electric fencing so lightweight I could carry and lay out the entire thing by myself—and then wheeling into it the shademobile, called the Gobbledy-Go. The turkeys rest under the Gobbledy-Go by day and roost on top of it at night. They happily follow the contraption into the fresh pasture to feast on the grass, which they seemed to enjoy even more than the chickens do. A turkey consumes a long blade of grass by neatly folding it over and over again with its beak, as if making origami. Joel likes to run his turkeys in the orchard, where they eat the bugs, mow the grass, and fertilize the trees and vines. (Turkeys will eat much more grass than chickens, and they don't damage crops the way chickens can.) "If you run turkeys in a grape orchard," Joel explained, "you can afford to stock the birds at only seventy percent of normal density, and space the vines at seventy percent of what's standard, because you're getting two crops off the same land. And at seventy percent you get much healthier birds and grapevines than you would at one hundred percent. That's the beauty of stacking." By industry standards, the turkey and grape holons

are each less than 100 percent efficient; together, however, they produce more than either enterprise would yield if fully stocked, and they do so without fertilizer, weeding, or pesticide.

I had witnessed one of the most winning examples of stacking in the cattle barn during my first visit to Polyface back in March. The barn is an unfancy open-sided structure where the cattle spend three months during the winter, each day consuming twenty-five pounds of hay and producing fifty pounds of manure. (Water makes up the difference.) But instead of regularly mucking out the barn, Joel leaves the manure in place, every few days covering it with another layer of woodchips or straw. As this layer cake of manure, woodchips, and straw gradually rises beneath the cattle, Joel simply raises the adjustable feed gate from which they get their ration of hay; by winter's end the bedding, and the cattle, can be as much as three feet off the ground. There's one more secret ingredient Joel adds to each layer of this cake: a few bucketfuls of corn. All winter long the layered bedding composts, in the process generating heat to warm the barn (thus reducing the animals' feed requirements), and fermenting the corn. Joel calls it his cattle's electric blanket.

Why the corn? Because there's nothing a pig enjoys more than forty-proof corn, and there's nothing he's better equipped to do than root it out with his powerful snout and exquisite sense of smell. "I call them my pigaerators," Salatin said proudly as he showed me into the barn. As soon as the cows head out to pasture in the spring, several dozen pigs come in, proceeding systematically to turn and aerate the compost in their quest for kernels of alcoholic corn. What had been an anaerobic decomposition suddenly turns aerobic, which dramatically heats and speeds up the process, killing any pathogens. The result, after a few weeks of pigaerating, is a rich, cakey compost ready to use.

"This is the sort of farm machinery I like: never needs its oil changed, appreciates over time, and when you're done with it you eat it." We were sitting on the rail of a wooden paddock, watching the pigs do their thing—a thing, of course, we weren't having to do ourselves. The line about the pigaerators was obviously well-worn. But the cliché that kept banging around in my head was "happy as a pig in shit."

Buried clear to their butts in composting manure, a bobbing sea of wriggling hams and corkscrew tails, these were the happiest pigs I'd ever seen.

I couldn't look at their spiraled tails, which cruised above the earthy mass like conning towers on submarines, without thinking about the fate of pigtails in industrial hog production. Simply put, there *are* no pigtails in industrial hog production. Farmers "dock," or snip off, the tails at birth, a practice that makes a certain twisted sense if you follow the logic of industrial efficiency on a hog farm. Piglets in these CAFOs are weaned from their mothers ten days after birth (compared with thirteen weeks in nature) because they gain weight faster on their drug-fortified feed than on sow's milk. But this premature weaning leaves the pigs with a lifelong craving to suck and chew, a need they gratify in confinement by biting the tail of the animal in front of them. A normal pig would fight off his molester, but a demoralized pig has stopped caring. "Learned helplessness" is the psychological term, and it's not uncommon in CAFOs, where tens of thousands of hogs spend their entire lives ignorant of earth or straw or sunshine, crowded together beneath a metal roof standing on metal slats suspended over a septic tank. It's not surprising that an animal as intelligent as a pig would get depressed under these circumstances, and a depressed pig will allow his tail to be chewed on to the point of infection. Since treating sick pigs is not economically efficient, these underperforming production units are typically clubbed to death on the spot.

Tail docking is the USDA's recommended solution to the porcine "vice" of tail chewing. Using a pair of pliers and no anesthetic, most—but not quite all—of the tail is snipped off. Why leave the little stump? Because the whole point of the exercise is not to remove the object of tail biting so much as to render it even more sensitive. Now a bite to the tail is so painful that even the most demoralized pig will struggle to resist it. Horrible as it is to contemplate, it's not hard to see how the road to such a hog hell is smoothly paved with the logic of industrial efficiency.

A very different concept of efficiency sponsors the hog heaven on display here in Salatin's barn, one predicated on what he calls "the pigness of the pig." These pigs too were being exploited—in this case, tricked into making compost as well as pork. What distinguishes Salatin's system is that it is designed around the natural predilections of the pig rather than around the requirements of a production system to which the pigs are then conformed. Pig happiness is simply the by-product of treating a pig as a pig rather than as "a protein machine with flaws"—flaws such as pigtails and a tendency, when emiserated, to get stressed.

Salatin reached down deep where his pigs were happily rooting and brought a handful of fresh compost right up to my nose. What had been cow manure and woodchips just a few weeks before now smelled as sweet and warm as the forest floor in summertime, a miracle of transubstantiation. As soon as the pigs complete their alchemy, Joel will spread the compost on his pastures. There it will feed the grasses, so the grasses might again feed the cows, the cows the chickens, and so on until the snow falls, in one long, beautiful, and utterly convincing proof that in a world where grass can eat sunlight and food animals can eat grass, there is indeed a free lunch.

2. TUESDAY AFTERNOON

After our own quick lunch (ham salad and deviled eggs), Joel and I drove to town in his pickup to make a delivery and take care of a few errands. It felt sweet to be sitting down for a while, especially after a morning taken up with loading the hay we'd baled the day before into the hayloft. For me this rather harrowing operation involved attempting to catch fifty-pound bales that Galen tossed in my general direction from the top of the hay wagon. The ones that didn't completely knock me over I hoisted onto a conveyor belt that carried them to Daniel and Peter, stationed up in the hayloft. It was an assembly line, more or less, and as soon as I fell behind (or just fell, literally) the hay bales piled up fast at my station; I felt like Lucille Ball at the candy factory. I joked to Joel that, contrary to his claims that the animals did most of the real work on this farm, it seemed to me they'd left plenty of it for us.

On a farm, complexity sounds an awful lot like hard work, Joel's claims to the contrary notwithstanding. As much work as the animals do, that's still us humans out there moving the cattle every evening, dragging the broiler pens across the field before breakfast (something I'd pledged I'd wake up in time for the next day), and towing chicken coops hither and yon according to a schedule tied to the life cycle of fly larvae and the nitrogen load of chicken manure. My guess is that there aren't too many farmers today who are up for either the physical or mental challenge of this sort of farming, not when industrializing promises to simplify the job. Indeed, a large part of the appeal of industrial farming is its panoply of labor- and thought-saving devices: machines of every description to do the physical work, and chemicals to keep crops and animals free from pests with scarcely a thought from the farmer. George Naylor works his fields maybe fifty days out of the year; Joel and Daniel and two interns are out there every day sunrise to sunset for a good chunk of the year.

Yet Joel and Daniel plainly relish their work, partly because it is so varied from day to day and even hour to hour, and partly because they find it endlessly interesting. Wendell Berry has written eloquently about the intellectual work that goes into farming well, especially into solving the novel problems that inevitably crop up in a natural system as complex as a farm. You don't see much of this sort of problem-solving in agriculture today, not when so many solutions come ready-made in plastic bottles. So much of the intelligence and local knowledge in agriculture has been removed from the farm to the laboratory, and then returned to the farm in the form of a chemical or machine. "Whose head is the farmer using?" Berry asks in one of his essays. "Whose head is using the farmer?"

"Part of the problem is, you've got a lot of D students left on the farm today," Joel said, as we drove around Staunton running errands. "The guidance counselors encouraged all the A students to leave home and go to college. There's been a tremendous brain drain in rural America. Of course that suits Wall Street just fine; Wall Street is always trying to extract brainpower and capital from the countryside. First they take

the brightest bulbs off the farm and put them to work in Dilbert's cubicle, and then they go after the capital of the dimmer ones who stayed behind, by selling them a bunch of gee-whiz solutions to their problems." This isn't just the farmer's problem, either. "It's a foolish culture that entrusts its food supply to simpletons."

It isn't hard to see why there isn't much institutional support for the sort of low-capital, thought-intensive farming Joel Salatin practices: He buys next to nothing. When a livestock farmer is willing to "practice complexity"—to choreograph the symbiosis of several different animals, each of which has been allowed to behave and eat as it evolved to—he will find he has little need for machinery, fertilizer, and, most strikingly, chemicals. He finds he has no sanitation problem or any of the diseases that result from raising a single animal in a crowded monoculture and then feeding it things it wasn't designed to eat. This is perhaps the greatest efficiency of a farm treated as a biological system: health.

I was struck by the fact that for Joel abjuring agrochemicals and pharmaceuticals is not so much a goal of his farming, as it so often is in organic agriculture, as it is an indication that his farm is functioning well. "In nature health is the default," he pointed out. "Most of the time pests and disease are just nature's way of telling the farmer he's doing something wrong."

At Polyface no one ever told me not to touch the animals, or asked me to put on a biohazard suit before going into the brooder house. The reason I had to wear one at Petaluma Poultry is because that system—a monoculture of chickens raised in close confinement—is inherently precarious, and the organic rules' prohibition on antibiotics puts it at a serious disadvantage. Maintaining a single-species animal farm on an industrial scale isn't easy without pharmaceuticals and pesticides. Indeed, that's why these chemicals were invented in the first place, to keep shaky monocultures from collapsing. Sometimes the large-scale organic farmer looks like someone trying to practice industrial agriculture with one hand tied behind his back.

By the same token, a reliance on agrochemicals destroys the infor-

mation feedback loop on which an attentive farmer depends to improve his farming. "Meds just mask genetic weaknesses," Joel explained one afternoon when we were moving the cattle. "My goal is always to improve the herd, adapt it to the local conditions by careful culling. To do this I need to know: Who has a propensity for pinkeye? For worms? You simply have no clue if you're giving meds all the time."

"So you tell me, who's really in this so-called information economy? Those who learn from what they observe on their farm, or those who rely on concoctions from the devil's pantry?"

Of course the simplest, most traditional measure of a farm's efficiency is how much food it produces per unit of land; by this yardstick too Polyface is impressively efficient. I asked Joel how much food Polyface produces in a season, and he rattled off the following figures:

30,000 dozen eggs
12,000 broilers
800 stewing hens
50 beeves (representing 25,000 pounds of beef)
250 hogs (50,000 pounds of pork)
800 turkeys
500 rabbits.

This seemed to me a truly astonishing amount of food from one hundred acres of grass. But when I put it that way to Joel that afternoon—we were riding the ATV up to the very top of the hill to visit the hogs in their summer quarters—he questioned my accounting method. It was far too simple.

"Sure, you can write that we produced all that food from a hundred open acres, but if you really want to be accurate about it, then you've got to count the four hundred and fifty acres of woodlot too." I didn't get that at all. I knew the woodlot was an important source of farm income in the winter—Joel and Daniel operate a small sawmill from

which they sell lumber and mill whatever wood they need to build sheds and barns (and Daniel's new house). But what in the world did the forest have to do with producing food?

Joel proceeded to count the ways. Most obviously, the farm's water supply depended on its forests to hold moisture and prevent erosion. Many of the farm's streams and ponds would simply dry up if not for the cover of trees. Nearly all of the farm's 550 acres had been deforested when the Salatins arrived; one of the first things Bill Salatin did was plant trees on all the north-facing slopes.

"Feel how cool it is in here." We were passing through a dense stand of oak and hickory. "Those deciduous trees work like an air conditioner. That reduces the stress on the animals in summer."

Suddenly we arrived at a patch of woodland that looked more like a savanna than a forest: The trees had been thinned and all around them grew thick grasses. This was one of the pig paddocks that Joel had carved out of the woods with the help of the pigs themselves. "All we do to make a new pig paddock is fence off a quarter acre of forest, thin out the saplings to let in some light, and then let the pigs do their thing." Their thing includes eating down the brush and rooting around in the stony ground, disturbing the soil in a way that induces the grass seed already present to germinate. Within several weeks, a lush stand of wild rye and foxtail emerges among the trees, and a savanna is born. Shady and cool, this looked like ideal habitat for the sunburn-prone pigs, who were avidly nosing through the tall grass and scratching their backs against the trees. There is something viscerally appealing about a savanna, with its pleasing balance of open grass and trees, and something profoundly heartening about the idea that, together, farmer and pigs could create such beauty here in the middle of a brushy second-growth forest.

But Joel wasn't through counting the benefits of woodland to a farm; idyllic pig habitat was the least of it.

"There's not a spreadsheet in the world that can measure the value of maintaining forest on the northern slopes of a farm. Start with those trees easing the swirling of the air in the pastures. That might not seem like a

big deal, but it reduces evaporation in the fields—which means more water for the grass. Plus, a grass plant burns up fifteen percent of its calories just defying gravity, so if you can stop it from being wind whipped, you greatly reduce the energy it uses keeping its photovoltaic array pointed toward the sun. More grass for the cows. That's the efficiency of a hedgerow surrounding a small field, something every farmer used to understand before 'fencerow to fencerow' became USDA mantra."

Then there is the water-holding capacity of trees, he explained, which on a north slope literally pumps water uphill. Next was all the ways a forest multiplies a farm's biodiversity. More birds on a farm mean fewer insects, but most birds won't venture more than a couple hundred yards from the safety of cover. Like many species, their preferred habitat is the edge between forest and field. The biodiversity of the forest edge also helps control predators. As long as the weasels and coyotes have plenty of chipmunks and voles to eat, they're less likely to venture out and prey on the chickens.

There was more. On a steep northern slope trees will produce much more biomass than will grass. "We're growing carbon in the woods for the rest of the farm—not just the firewood to keep us warm in the winter, but also the wood chips that go into making our compost." Making good compost depends on the proper ratio of carbon to nitrogen; the carbon is needed to lock down the more volatile nitrogen. It takes a lot of wood chips to compost chicken or rabbit waste. So the carbon from the woodlots feeds the fields, finding its way into the grass and, from there, into the beef. Which it turns out is not only grass fed but tree fed as well.

These woods represented a whole other order of complexity that I had failed to take into account. I realized that Joel didn't look at this land the same way I did, or had before this afternoon: as a hundred acres of productive grassland patchworked into four hundred and fifty acres of unproductive forest. It was all of a biological piece, the trees and the grasses and the animals, the wild and the domestic, all part of a single ecological system. By any conventional accounting, the forests here represented a waste of land that could be put to productive use.

But if Joel were to cut down the trees to graze more cattle, as any conventional accounting would recommend, the system would no longer be quite as whole or as healthy as it is. *You can't just do one thing.*

For some reason the image that stuck with me from that day was that slender blade of grass in a too-big, wind-whipped pasture, burning all those calories just to stand up straight and keep its chloroplasts aimed at the sun. I'd always thought of the trees and grasses as antagonists—another zero-sum deal in which the gain of the one entails the loss of the other. To a point, this is true: More grass means less forest; more forest less grass. But either-or is a construction more deeply woven into our culture than into nature, where even antagonists depend on one another and the liveliest places are the edges, the in-betweens or both-ands. So it is with the blade of grass and the adjacent forest as, indeed, with all the species sharing this most complicated farm. Relations are what matter most, and the health of the cultivated turns on the health of the wild. Before I came to Polyface I'd read a sentence of Joel's that in its diction had struck me as an awkward hybrid of the economic and the spiritual. I could see now how characteristic that mixing is, and that perhaps the sentence isn't so awkward after all: "One of the greatest assets of a farm is the sheer ecstasy of life."