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Power Steer

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Garden City, Kan., missed out on the suburban building boom of the postwar years. What it got instead were sprawling subdivisions of cattle. These feedlots -- the nation's first -- began rising on the high plains of western Kansas in the 50's, and by now developments catering to cows are far more common here than developments catering to people.

You'll be speeding down one of Finney County's ramrod roads when the empty, dun-colored prairie suddenly turns black and geometric, an urban grid of steel-fenced rectangles as far as the eye can see -- which in Kansas is really far. I say "suddenly," but in fact a swiftly intensifying odor (an aroma whose Proustian echoes are more bus-station-men's-room than cow-in-the-country) heralds the approach of a feedlot for more than a mile. Then it's upon you: Poky Feeders, population 37,000. Cattle pens stretch to the horizon, each one home to 150 animals standing dully or lying around in a grayish mud that it eventually dawns on you isn't mud at all. The pens line a network of unpaved roads that loop around vast waste lagoons on their way to the feedlot's beating heart: a chugging, silvery feed mill that soars like an industrial cathedral over this teeming metropolis of meat.

I traveled to Poky early in January with the slightly improbable notion of visiting one particular resident: a young black steer that I'd met in the fall on a ranch in Vale, S.D. The steer, in fact, belonged to me. I'd purchased him as an 8-month-old calf from the Blair brothers, Ed and Rich, for $598. I was paying Poky Feeders $1.60 a day for his room, board and meds and hoped to sell him at a profit after he was fattened.

My interest in the steer was not strictly financial, however, or even gustatory, though I plan to retrieve some steaks from the Kansas packing plant where No. 534, as he is known, has an appointment with the stunner in June. No, my primary interest in this animal was educational. I wanted to find out how a modern, industrial steak is produced in America these days, from insemination to slaughter.

Eating meat, something I have always enjoyed doing, has become problematic in recent years. Though beef consumption spiked upward during the flush 90's, the longer-term trend is down, and many people will tell you they no longer eat the stuff. Inevitably they'll bring up mad-cow disease (and the accompanying revelation that industrial agriculture has transformed these ruminants into carnivores -- indeed, into cannibals). They might mention their concerns about E. coli contamination or antibiotics in the feed. Then there are the many environmental problems, like groundwater pollution, associated with "Concentrated Animal Feeding Operations." (The word "farm" no longer applies.) And of course there are questions of animal welfare. How are we treating the animals we eat while they're alive, and then how humanely are we "dispatching" them, to borrow an industry euphemism?

Meat-eating has always been a messy business, shadowed by the shame of killing and, since Upton Sinclair's writing of "The Jungle," by questions about what we're really eating when we eat meat. Forgetting, or willed ignorance, is the preferred strategy of many beef eaters, a strategy abetted by the industry. (What grocery-store item is more silent about its origins than a shrink-wrapped steak?) Yet I recently began to feel that ignorance was no longer tenable. If I was going to continue to eat red meat, then I owed it to myself, as well as to the animals, to take more responsibility for the invisible but crucial transaction between ourselves and the animals we eat. I'd try to own it, in other words.

So this is the biography of my cow.

The Blair brothers ranch occupies 11,500 acres of short-grass prairie a few miles outside Sturgis, S.D., directly in the shadow of Bear Butte. In November, when I visited, the turf forms a luxuriant pelt of grass oscillating yellow and gold in the constant wind and sprinkled with perambulating black dots: Angus cows and calves grazing.

Ed and Rich Blair run what's called a "cow-calf" operation, the first stage of beef production, and the stage least changed by the modern industrialization of meat. While the pork and chicken industries have consolidated the entire life cycles of those animals under a single roof, beef cattle are still born on thousands of independently owned ranches. Although four giant meatpacking companies (Tyson's subsidiary IBP, Monfort, Excel and National) now slaughter and market more than 80 percent of the beef cattle born in this country, that concentration represents the narrow end of a funnel that starts out as wide as the great plains.

The Blairs have been in the cattle business for four generations. Although there are new wrinkles to the process -- artificial insemination to improve genetics, for example -- producing beef calves goes pretty much as it always has, just faster. Calving season begins in late winter, a succession of subzero nights spent yanking breeched babies out of their bellowing mothers. In April comes the first spring roundup to work the newborn calves (branding, vaccination, castration); then more roundups in early summer to inseminate

the cows ($15 mail-order straws of elite bull semen have pretty much put the resident stud out of work); and weaning in the fall. If all goes well, your herd of 850 cattle has increased to 1,600 by the end of the year.

My steer spent his first six months in these lush pastures alongside his mother, No. 9,534. His father was a registered Angus named GAR Precision 1,680, a bull distinguished by the size and marbling of his offspring's rib-eye steaks. Born last March 13 in a birthing shed across the road, No. 534 was turned out on pasture with his mother as soon as the 80-pound calf stood up and began nursing. After a few weeks, the calf began supplementing his mother's milk by nibbling on a salad bar of mostly native grasses: western wheatgrass, little bluestem, green needlegrass.

Apart from the trauma of the April day when he was branded and castrated, you could easily imagine No. 534 looking back on those six months grazing at his mother's side as the good old days -- if, that is, cows do look back. ("They do not know what is meant by yesterday or today," Friedrich Nietzsche wrote, with a note of envy, of grazing cattle, "fettered to the moment and its pleasure or displeasure, and thus neither melancholy or bored." Nietzsche clearly had never seen a feedlot.) It may be foolish to presume to know what a cow experiences, yet we can say that a cow grazing on grass is at least doing what he has been splendidly molded by evolution to do. Which isn't a bad definition of animal happiness. Eating grass, however, is something that, after October, my steer would never do again.

Although the modern cattle industry all but ignores it, the reciprocal relationship between cows and grass is one of nature's underappreciated wonders. For the grasses, the cow maintains their habitat by preventing trees and shrubs from gaining a foothold; the animal also spreads grass seed, planting it with its hoofs and fertilizing it. In exchange for these services, the grasses offer the ruminants a plentiful, exclusive meal. For cows, sheep and other grazers have the unique ability to convert grass -- which single-stomached creatures like us can't digest -- into high-quality protein. They can do this because they possess a rumen, a 45-gallon fermentation tank in which a resident population of bacteria turns grass into metabolically useful organic acids and protein.

This is an excellent system for all concerned: for the grasses, for the animals and for us. What's more, growing meat on grass can make superb ecological sense: so long as the rancher practices rotational grazing, it is a sustainable, solar-powered system for producing food on land too arid or hilly to grow anything else.

So if this system is so ideal, why is it that my cow hasn't tasted a blade of grass since October? Speed, in a word. Cows raised on grass simply take longer to reach slaughter weight than cows raised on a richer diet, and the modern meat industry has devoted itself to shortening a beef calf's allotted time on earth. "In my grandfather's day, steers were 4 or 5 years old at slaughter," explained Rich Blair, who, at 45, is the younger of the brothers by four years. "In the 50's, when my father was ranching, it was 2 or 3. Now we get there at 14 to 16 months." Fast food indeed. What gets a beef calf from 80 to 1,200 pounds in 14 months are enormous quantities of corn, protein supplements -- and drugs, including growth hormones. These "efficiencies," all of which come at a price, have transformed raising cattle into a high-volume, low-margin business. Not everybody is convinced that this is progress. "Hell," Ed Blair told me, "my dad made more money on 250 head than we do on 850."

Weaning marks the fateful moment when the natural, evolutionary logic represented by a ruminant grazing on grass bumps up against the industrial logic that, with stunning speed, turns that animal into a box of beef. This industrial logic is rational and even irresistible -- after all, it has succeeded in transforming beef from a luxury item into everyday fare for millions of people. And yet the further you follow it, the more likely you are to wonder if that rational logic might not also be completely insane.

In early October, a few weeks before I met him, No. 534 was weaned from his mother. Weaning is perhaps the most traumatic time on a ranch for animals and ranchers alike; cows separated from their calves will mope and bellow for days, and the calves themselves, stressed by the change in circumstance and diet, are prone to get sick.

On many ranches, weaned calves go directly from the pasture to the sale barn, where they're sold at auction, by the pound, to feedlots. The Blairs prefer to own their steers straight through to slaughter and to keep them on the ranch for a couple of months of "backgrounding" before sending them on the 500-mile trip to Poky Feeders. Think of backgrounding as prep school for feedlot life: the animals are confined in a pen, "bunk broken" -- taught to eat from a trough -- and gradually accustomed to eating a new, unnatural diet of grain. (Grazing cows encounter only tiny amounts of grain, in the form of grass seeds.)

It was in the backgrounding pen that I first met No. 534 on an unseasonably warm afternoon in November. I'd told the Blairs I wanted to follow one of their steers through the life cycle; Ed, 49, suggested I might as well buy a steer, as a way to really understand the daunting economics of modern ranching. Ed and Rich told me what to look for: a broad, straight back and thick hindquarters. Basically, you want a strong frame on which to hang a lot of meat. I was also looking for a memorable face in this Black Angus sea, one that would stand out in the feedlot crowd. Almost as soon as I started surveying the 90 or so steers in the pen, No. 534 moseyed up to the railing and made eye contact. He had a wide, stout frame and was brockle- faced -- he had three distinctive white blazes. If not for those markings, Ed said, No. 534 might have been spared castration and sold as a bull; he was that good-looking. But the white blazes indicate the presence of Hereford blood, rendering him ineligible for life as an Angus stud. Tough break.

Rich said he would calculate the total amount I owed the next time No. 534 got weighed but that the price would be $98 a hundredweight for an animal of this quality. He would then bill me for all expenses (feed, shots, et cetera) and, beginning in January, start passing on the weekly "hotel charges" from Poky Feeders. In June we'd find out from the packing plant how well my investment

had panned out: I would receive a payment for No. 534 based on his carcass weight, plus a premium if he earned a U.S.D.A. grade of choice or prime. "And if you're worried about the cattle market," Rich said jokingly, referring to its post-Sept. 11 slide, "I can sell you an option too." Option insurance has become increasingly popular among cattlemen in the wake of mad-cow and foot-and-mouth disease.

Rich handles the marketing end of the business out of an office in Sturgis, where he also trades commodities. In fact you'd never guess from Rich's unlined, indoorsy face and golfish attire that he was a rancher. Ed, by contrast, spends his days on the ranch and better looks the part, with his well-creased visage, crinkly cowboy eyes and ever-present plug of tobacco. His cap carries the same prairie-flat slogan I'd spotted on the ranch's roadside sign: "Beef: It's What's for Dinner."

My second morning on the ranch, I helped Troy Hadrick, Ed's son-in-law and a ranch hand, feed the steers in the backgrounding pen. A thickly muscled post of a man, Hadrick is 25 and wears a tall black cowboy hat perpetually crowned by a pair of mirrored Oakley sunglasses. He studied animal science at South Dakota State and is up on the latest university thinking on cattle nutrition, reproduction and medicine. Hadrick seems to relish everything to do with ranching, from calving to wielding the artificial-insemination syringe.

Hadrick and I squeezed into the heated cab of a huge swivel-hipped tractor hooked up to a feed mixer: basically, a dump truck with a giant screw through the middle to blend ingredients. First stop was a hopper filled with Rumensin, a powerful antibiotic that No. 534 will consume with his feed every day for the rest of his life. Calves have no need of regular medication while on grass, but as soon as they're placed in the backgrounding pen, they're apt to get sick. Why? The stress of weaning is a factor, but the main culprit is the feed. The shift to a "hot ration" of grain can so disturb the cow's digestive process -- its rumen, in particular -- that it can kill the animal if not managed carefully and accompanied by antibiotics.

After we'd scooped the ingredients into the hopper and turned on the mixer, Hadrick deftly sidled the tractor alongside the pen and flipped a switch to release a dusty tan stream of feed in a long, even line. No. 534 was one of the first animals to belly up to the rail for breakfast. He was heftier than his pen mates and, I decided, sparkier too. That morning, Hadrick and I gave each calf six pounds of corn mixed with seven pounds of ground alfalfa hay and a quarter-pound of Rumensin. Soon after my visit, this ration would be cranked up to 14 pounds of corn and 6 pounds of hay -- and added two and a half pounds every day to No. 534.

While I was on the ranch, I didn't talk to No. 534, pet him or otherwise try to form a connection. I also decided not to give him a name, even though my son proposed a pretty good one after seeing a snapshot. ("Night.") My intention, after all, is to send this animal to slaughter and then eat some of him. No. 534 is not a pet, and I certainly don't want to end up with an ox in my backyard because I suddenly got sentimental.

As fall turned into winter, Hadrick sent me regular e-mail messages apprising me of my steer's progress. On Nov. 13 he weighed 650 pounds; by Christmas he was up to 798, making him the seventh-heaviest steer in his pen, an achievement in which I, idiotically, took a measure of pride. Between Nov. 13 and Jan. 4, the day he boarded the truck for Kansas, No. 534 put away 706 pounds of corn and 336 pounds of alfalfa hay, bringing his total living expenses for that period to $61.13. I was into this deal now for $659.

Hadrick's e-mail updates grew chattier as time went on, cracking a window on the rancher's life and outlook. I was especially struck by his relationship to the animals, how it manages to be at once intimate and unsentimental. One day Hadrick is tenderly nursing a newborn at 3 a.m., the next he's "having a big prairie oyster feed" after castrating a pen of bull calves.

Hadrick wrote empathetically about weaning ("It's like packing up and leaving the house when you are 18 and knowing you will never see your parents again") and with restrained indignation about "animal activists and city people" who don't understand the first thing about a rancher's relationship to his cattle. Which, as Hadrick put it, is simply this: "If we don't take care of these animals, they won't take care of us."

"Everyone hears about the bad stuff," Hadrick wrote, "but they don't ever see you give C.P.R. to a newborn calf that was born backward or bringing them into your house and trying to warm them up on your kitchen floor because they were born on a minus-20-degree night. Those are the kinds of things ranchers will do for their livestock. They take precedence over most everything in your life. Sorry for the sermon."

To travel from the ranch to the feedlot, as No. 534 and I both did (in separate vehicles) the first week in January, feels a lot like going from the country to the big city. Indeed, a cattle feedlot is a kind of city, populated by as many as 100,000 animals. It is very much a premodern city, however -- crowded, filthy and stinking, with open sewers, unpaved roads and choking air.

The urbanization of the world's livestock is a fairly recent historical development, so it makes a certain sense that cow towns like Poky Feeders would recall human cities several centuries ago. As in 14th-century London, the metropolitan digestion remains vividly on display: the foodstuffs coming in, the waste streaming out. Similarly, there is the crowding together of recent arrivals from who knows where, combined with a lack of modern sanitation. This combination has always been a recipe for disease; the only reason contemporary animal cities aren't as plague-ridden as their medieval counterparts is a single historical anomaly: the modern antibiotic.

I spent the better part of a day walking around Poky Feeders, trying to understand how its various parts fit together. In any city, it's easy to lose track of nature -- of the connections between various species and the land on which everything ultimately depends. The

feedlot's ecosystem, I could see, revolves around corn. But its food chain doesn't end there, because the corn itself grows somewhere else, where it is implicated in a whole other set of ecological relationships. Growing the vast quantities of corn used to feed livestock in this country takes vast quantities of chemical fertilizer, which in turn takes vast quantities of oil -- 1.2 gallons for every bushel. So the modern feedlot is really a city floating on a sea of oil.

I started my tour at the feed mill, the yard's thundering hub, where three meals a day for 37,000 animals are designed and mixed by computer. A million pounds of feed passes through the mill each day. Every hour of every day, a tractor-trailer pulls up to disgorge another 25 tons of corn. Around the other side of the mill, tanker trucks back up to silo-shaped tanks, into which they pump thousands of gallons of liquefied fat and protein supplement. In a shed attached to the mill sit vats of liquid vitamins and synthetic estrogen; next to these are pallets stacked with 50-pound sacks of Rumensin and tylosin, another antibiotic. Along with alfalfa hay and corn silage for roughage, all these ingredients are blended and then piped into the dump trucks that keep Poky's eight and a half miles of trough filled.

The feed mill's great din is made by two giant steel rollers turning against each other 12 hours a day, crushing steamed corn kernels into flakes. This was the only feed ingredient I tasted, and it wasn't half bad; not as crisp as Kellogg's, but with a cornier flavor. I passed, however, on the protein supplement, a sticky brown goop consisting of molasses and urea.

Corn is a mainstay of livestock diets because there is no other feed quite as cheap or plentiful: thanks to federal subsidies and ever-growing surpluses, the price of corn ($2.25 a bushel) is 50 cents less than the cost of growing it. The rise of the modern factory farm is a direct result of these surpluses, which soared in the years following World War II, when petrochemical fertilizers came into widespread use. Ever since, the U.S.D.A.'s policy has been to help farmers dispose of surplus corn by passing as much of it as possible through the digestive tracts of food animals, converting it into protein. Compared with grass or hay, corn is a compact and portable foodstuff, making it possible to feed tens of thousands of animals on small plots of land. Without cheap corn, the modern urbanization of livestock would probably never have occurred.

We have come to think of "cornfed" as some kind of old-fashioned virtue; we shouldn't. Granted, a cornfed cow develops well-marbled flesh, giving it a taste and texture American consumers have learned to like. Yet this meat is demonstrably less healthy to eat, since it contains more saturated fat. A recent study in The European Journal of Clinical Nutrition found that the meat of grass-fed livestock not only had substantially less fat than grain-fed meat but that the type of fats found in grass-fed meat were much healthier. (Grass-fed meat has more omega 3 fatty acids and fewer omega 6, which is believed to promote heart disease; it also contains betacarotine and CLA, another "good" fat.) A growing body of research suggests that many of the health problems associated with eating beef are really problems with cornfed beef. In the same way ruminants have not evolved to eat grain, humans may not be well adapted to eating grain-fed animals. Yet the U.S.D.A.'s grading system continues to reward marbling -- that is, intermuscular fat -- and thus the feeding of corn to cows.

The economic logic behind corn is unassailable, and on a factory farm, there is no other kind. Calories are calories, and corn is the cheapest, most convenient source of calories. Of course the identical industrial logic -- protein is protein -- led to the feeding of rendered cow parts back to cows, a practice the F.D.A. banned in 1997 after scientists realized it was spreading mad-cow disease.

Make that mostly banned. The F.D.A.'s rules against feeding ruminant protein to ruminants make exceptions for "blood products" (even though they contain protein) and fat. Indeed, my steer has probably dined on beef tallow recycled from the very slaughterhouse he's heading to in June. "Fat is fat," the feedlot manager shrugged when I raised an eyebrow.

F.D.A. rules still permit feedlots to feed nonruminant animal protein to cows. (Feather meal is an accepted cattle feed, as are pig and fish protein and chicken manure.) Some public-health advocates worry that since the bovine meat and bone meal that cows used to eat is now being fed to chickens, pigs and fish, infectious prions could find their way back into cattle when they eat the protein of the animals that have been eating them. To close this biological loophole, the F.D.A. is now considering tightening its feed rules.

Until mad-cow disease, remarkably few people in the cattle business, let alone the general public, comprehended the strange semicircular food chain that industrial agriculture had devised for cattle (and, in turn, for us). When I mentioned to Rich Blair that I'd been surprised to learn that cows were eating cows, he said, "To tell the truth, it was kind of a shock to me too." Yet even today, ranchers don't ask many questions about feedlot menus. Not that the answers are so easy to come by. When I asked Poky's feedlot manager what exactly was in the protein supplement, he couldn't say. "When we buy supplement, the supplier says it's 40 percent protein, but they don't specify beyond that." When I called the supplier, it wouldn't divulge all its "proprietary ingredients" but promised that animal parts weren't among them. Protein is pretty much still protein.

Compared with ground-up cow bones, corn seems positively wholesome. Yet it wreaks considerable havoc on bovine digestion. During my day at Poky, I spent an hour or two driving around the yard with Dr. Mel Metzen, the staff veterinarian. Metzen, a 1997 graduate of Kansas State's vet school, oversees a team of eight cowboys who spend their days riding the yard, spotting sick cows and bringing them in for treatment. A great many of their health problems can be traced to their diet. "They're made to eat forage," Metzen said, "and we're making them eat grain."

Perhaps the most serious thing that can go wrong with a ruminant on corn is feedlot bloat. The rumen is always producing copious amounts of gas, which is normally expelled by belching during rumination. But when the diet contains too much starch and too little roughage, rumination all but stops, and a layer of foamy slime that can trap gas forms in the rumen. The rumen inflates like a balloon,

pressing against the animal's lungs. Unless action is promptly taken to relieve the pressure (usually by forcing a hose down the animal's esophagus), the cow suffocates.

A corn diet can also give a cow acidosis. Unlike that in our own highly acidic stomachs, the normal pH of a rumen is neutral. Corn makes it unnaturally acidic, however, causing a kind of bovine heartburn, which in some cases can kill the animal but usually just makes it sick. Acidotic animals go off their feed, pant and salivate excessively, paw at their bellies and eat dirt. The condition can lead to diarrhea, ulcers, bloat, liver disease and a general weakening of the immune system that leaves the animal vulnerable to everything from pneumonia to feedlot polio.

Cows rarely live on feedlot diets for more than six months, which might be about as much as their digestive systems can tolerate. "I don't know how long you could feed this ration before you'd see problems," Metzen said; another vet said that a sustained feedlot diet would eventually "blow out their livers" and kill them. As the acids eat away at the rumen wall, bacteria enter the bloodstream and collect in the liver. More than 13 percent of feedlot cattle are found at slaughter to have abscessed livers.

What keeps a feedlot animal healthy -- or healthy enough -- are antibiotics. Rumensin inhibits gas production in the rumen, helping to prevent bloat; tylosin reduces the incidence of liver infection. Most of the antibiotics sold in America end up in animal feed -- a practice that, it is now generally acknowledged, leads directly to the evolution of new antibiotic-resistant "superbugs." In the debate over the use of antibiotics in agriculture, a distinction is usually made between clinical and nonclinical uses. Public-health advocates don't object to treating sick animals with antibiotics; they just don't want to see the drugs lose their efficacy because factory farms are feeding them to healthy animals to promote growth. But the use of antibiotics in feedlot cattle confounds this distinction. Here the drugs are plainly being used to treat sick animals, yet the animals probably wouldn't be sick if not for what we feed them.

I asked Metzen what would happen if antibiotics were banned from cattle feed. "We just couldn't feed them as hard," he said. "Or we'd have a higher death loss." (Less than 3 percent of cattle die on the feedlot.) The price of beef would rise, he said, since the whole system would have to slow down.

"Hell, if you gave them lots of grass and space," he concluded dryly, "I wouldn't have a job."

Before heading over to Pen 43 for my reunion with No. 534, I stopped by the shed where recent arrivals receive their hormone implants. The calves are funneled into a chute, herded along by a ranch hand wielding an electric prod, then clutched in a restrainer just long enough for another hand to inject a slow-release pellet of Revlar, a synthetic estrogen, in the back of the ear. The Blairs' pen had not yet been implanted, and I was still struggling with the decision of whether to forgo what is virtually a universal practice in the cattle industry in the United States. (It has been banned in the European Union.)

American regulators permit hormone implants on the grounds that no risk to human health has been proved, even though measurable hormone residues do turn up in the meat we eat. These contribute to the buildup of estrogenic compounds in the environment, which some scientists believe may explain falling sperm counts and premature maturation in girls. Recent studies have also found elevated levels of synthetic growth hormones in feedlot wastes; these persistent chemicals eventually wind up in the waterways downstream of feedlots, where scientists have found fish exhibiting abnormal sex characteristics.

The F.D.A. is opening an inquiry into the problem, but for now, implanting hormones in beef cattle is legal and financially irresistible: an implant costs $1.50 and adds between 40 and 50 pounds to the weight of a steer at slaughter, for a return of at least $25. That could easily make the difference between profit and loss on my investment in No. 534. Thinking like a parent, I like the idea of feeding my son hamburgers free of synthetic hormones. But thinking like a cattleman, there was really no decision to make.

I asked Rich Blair what he thought. "I'd love to give up hormones," he said. "If the consumer said, We don't want hormones, we'd stop in a second. The cattle could get along better without them. But the market signal's not there, and as long as my competitor's doing it, I've got to do it, too."

Around lunch time, Metzen and I finally arrived at No. 534's pen. My first impression was that my steer had landed himself a decent piece of real estate. The pen is far enough from the feed mill to be fairly quiet, and it has a water view -- of what I initially thought was a reservoir, until I noticed the brown scum. The pen itself is surprisingly spacious, slightly bigger than a basketball court, with a concrete feed bunk out front and a freshwater trough in the back. I climbed over the railing and joined the 90 steers, which, en masse, retreated a few steps, then paused.

I had on the same carrot-colored sweater I'd worn to the ranch in South Dakota, hoping to jog my steer's memory. Way off in the back, I spotted him -- those three white blazes. As I gingerly stepped toward him, the quietly shuffling mass of black cowhide between us parted, and there No. 534 and I stood, staring dumbly at each other. Glint of recognition? None whatsoever. I told myself not to take it personally. No. 534 had been bred for his marbling, after all, not his intellect.

I don't know enough about the emotional life of cows to say with any confidence if No. 534 was miserable, bored or melancholy, but I would not say he looked happy. I noticed that his eyes looked a little bloodshot. Some animals are irritated by the fecal dust that floats in the feedlot air; maybe that explained the sullen gaze with which he fixed me. Unhappy or not, though, No. 534 had clearly been eating well. My animal had put on a couple hundred pounds since we'd last met, and he looked it: thicker across the shoulders and

round as a barrel through the middle. He carried himself more like a steer now than a calf, even though he was still less than a year old. Metzen complimented me on his size and conformation. "That's a handsome looking beef you've got there." (Aw, shucks.)

Staring at No. 534, I could picture the white lines of the butcher's chart dissecting his black hide: rump roast, flank steak, standing rib, brisket. One way of looking at No. 534 -- the industrial way -- was as an efficient machine for turning feed corn into beef. Every day between now and his slaughter date in June, No. 534 will convert 32 pounds of feed (25 of them corn) into another three and a half pounds of flesh. Poky is indeed a factory, transforming cheap raw materials into a less-cheap finished product, as fast as bovinely possible.

Yet the factory metaphor obscures as much as it reveals about the creature that stood before me. For this steer was not a machine in a factory but an animal in a web of relationships that link him to certain other animals, plants and microbes, as well as to the earth. And one of those other animals is us. The unnaturally rich diet of corn that has compromised No. 534's health is fattening his flesh in a way that in turn may compromise the health of the humans who will eat him. The antibiotics he's consuming with his corn were at that very moment selecting, in his gut and wherever else in the environment they wind up, for bacteria that could someday infect us and resist the drugs we depend on. We inhabit the same microbial ecosystem as the animals we eat, and whatever happens to it also happens to us.

I thought about the deep pile of manure that No. 534 and I were standing in. We don't know much about the hormones in it -- where they will end up or what they might do once they get there -- but we do know something about the bacteria. One particularly lethal bug most probably resided in the manure beneath my feet. Escherichia coli 0157 is a relatively new strain of a common intestinal bacteria (it was first isolated in the 1980's) that is common in feedlot cattle, more than half of whom carry it in their guts. Ingesting as few as 10 of these microbes can cause a fatal infection.

Most of the microbes that reside in the gut of a cow and find their way into our food get killed off by the acids in our stomachs, since they originally adapted to live in a neutral-pH environment. But the digestive tract of the modern feedlot cow is closer in acidity to our own, and in this new, manmade environment acid-resistant strains of E. coli have developed that can survive our stomach acids -- and go on to kill us. By acidifying a cow's gut with corn, we have broken down one of our food chain's barriers to infection. Yet this process can be reversed: James Russell, a U.S.D.A. microbiologist, has discovered that switching a cow's diet from corn to hay in the final days before slaughter reduces the population of E. coli 0157 in its manure by as much as 70 percent. Such a change, however, is considered wildly impractical by the cattle industry.

So much comes back to corn, this cheap feed that turns out in so many ways to be not cheap at all. While I stood in No. 534's pen, a dump truck pulled up alongside the feed bunk and released a golden stream of feed. The animals stepped up to the bunk for their lunch. The $1.60 a day I'm paying for three giant meals is a bargain only by the narrowest of calculations. It doesn't take into account, for example, the cost to the public health of antibiotic resistance or food poisoning by E. coli or all the environmental costs associated with industrial corn.

For if you follow the corn from this bunk back to the fields where it grows, you will find an 80-million-acre monoculture that consumes more chemical herbicide and fertilizer than any other crop. Keep going and you can trace the nitrogen runoff from that crop all the way down the Mississippi into the Gulf of Mexico, where it has created (if that is the right word) a 12,000-square-mile "dead zone."

But you can go farther still, and follow the fertilizer needed to grow that corn all the way to the oil fields of the Persian Gulf. No. 534 started life as part of a food chain that derived all its energy from the sun; now that corn constitutes such an important link in his food chain, he is the product of an industrial system powered by fossil fuel. (And in turn, defended by the military -- another uncounted cost of "cheap" food.) I asked David Pimentel, a Cornell ecologist who specializes in agriculture and energy, if it might be possible to calculate precisely how much oil it will take to grow my steer to slaughter weight. Assuming No. 534 continues to eat 25 pounds of corn a day and reaches a weight of 1,250 pounds, he will have consumed in his lifetime roughly 284 gallons of oil. We have succeeded in industrializing the beef calf, transforming what was once a solar-powered ruminant into the very last thing we need: another fossil-fuel machine.

Sometime in June, No. 534 will be ready for slaughter. Though only 14 months old, my steer will weigh more than 1,200 pounds and will move with the lumbering deliberateness of the obese. One morning, a cattle trailer from the National Beef plant in Liberal, Kan., will pull in to Poky Feeders, drop a ramp and load No. 534 along with 35 of his pen mates.

The 100-mile trip south to Liberal is a straight shot on Route 83, a two-lane highway on which most of the traffic consists of speeding tractor-trailers carrying either cattle or corn. The National Beef plant is a sprawling gray-and-white complex in a neighborhood of trailer homes and tiny houses a notch up from shanty. These are, presumably, the homes of the Mexican and Asian immigrants who make up a large portion of the plant's work force. The meat business has made southwestern Kansas an unexpectedly diverse corner of the country.

A few hours after their arrival in the holding pens outside the factory, a plant worker will open a gate and herd No. 534 and his pen mates into an alley that makes a couple of turns before narrowing down to a single-file chute. The chute becomes a ramp that leads the animals up to a second-story platform and then disappears through a blue door.

That door is as close to the kill floor as the plant managers were prepared to let me go. I could see whatever I wanted to farther on --

the cold room where carcasses are graded, the food-safety lab, the fabrication room where the carcasses are broken down into cuts -- on the condition that I didn't take pictures or talk to employees. But the stunning, bleeding and evisceration process was off limits to a journalist, even a cattleman-journalist like myself.

What I know about what happens on the far side of the blue door comes mostly from Temple Grandin, who has been on the other side and, in fact, helped to design it. Grandin, an assistant professor of animal science at Colorado State, is one of the most influential people in the United States cattle industry. She has devoted herself to making cattle slaughter less stressful and therefore more humane by designing an ingenious series of cattle restraints, chutes, ramps and stunning systems. Grandin is autistic, a condition she says has allowed her to see the world from the cow's point of view. The industry has embraced Grandin's work because animals under stress are not only more difficult to handle but also less valuable: panicked cows produce a surge of adrenaline that turns their meat dark and unappetizing. "Dark cutters," as they're called, sell at a deep discount.

Grandin designed the double-rail conveyor system in use at the National Beef plant; she has also audited the plant's killing process for McDonald's. Stories about cattle "waking up" after stunning only to be skinned alive prompted McDonald's to audit its suppliers in a program that is credited with substantial improvements since its inception in 1999. Grandin says that in cattle slaughter "there is the pre-McDonald's era and the post-McDonald's era -- it's night and day."

Grandin recently described to me what will happen to No. 534 after he passes through the blue door. "The animal goes into the chute single file," she began. "The sides are high enough so all he sees is the butt of the animal in front of him. As he walks through the chute, he passes over a metal bar, with his feet on either side. While he's straddling the bar, the ramp begins to decline at a 25-degree angle, and before he knows it, his feet are off the ground and he's being carried along on a conveyor belt. We put in a false floor so he can't look down and see he's off the ground. That would panic him."

Listening to Grandin's rather clinical account, I couldn't help wondering what No. 534 would be feeling as he approached his end. Would he have any inkling -- a scent of blood, a sound of terror from up the line -- that this was no ordinary day?

Grandin anticipated my question: "Does the animal know it's going to get slaughtered? I used to wonder that. So I watched them, going into the squeeze chute on the feedlot, getting their shots and going up the ramp at a slaughter plant. No difference. If they knew they were going to die, you'd see much more agitated behavior.

"Anyway, the conveyor is moving along at roughly the speed of a moving sidewalk. On a catwalk above stands the stunner. The stunner has a pneumatic-powered 'gun' that fires a steel bolt about seven inches long and the diameter of a fat pencil. He leans over and puts it smack in the middle of the forehead. When it's done correctly, it will kill the animal on the first shot."

For a plant to pass a McDonald's audit, the stunner needs to render animals "insensible" on the first shot 95 percent of the time. A second shot is allowed, but should that one fail, the plant flunks. At the line speeds at which meatpacking plants in the United States operate -- 390 animals are slaughtered every hour at National, which is not unusual -- mistakes would seem inevitable, but Grandin insists that only rarely does the process break down.

"After the animal is shot while he's riding along, a worker wraps a chain around his foot and hooks it to an overhead trolley. Hanging upside down by one leg, he's carried by the trolley into the bleeding area, where the bleeder cuts his throat. Animal rights people say they're cutting live animals, but that's because there's a lot of reflex kicking." This is one of the reasons a job at a slaughter plant is the most dangerous in America. "What I look for is, Is the head dead? It should be flopping like a rag, with the tongue hanging out. He'd better not be trying to hold it up -- then you've got a live one on the rail." Just in case, Grandin said, "they have another hand stunner in the bleed area."

Much of what happens next -- the de-hiding of the animal, the tying off of its rectum before evisceration -- is designed to keep the animal's feces from coming into contact with its meat. This is by no means easy to do, not when the animals enter the kill floor smeared with manure and 390 of them are eviscerated every hour. (Partly for this reason, European plants operate at much slower line speeds.) But since that manure is apt to contain lethal pathogens like E. coli 0157, and since the process of grinding together hamburger from hundreds of different carcasses can easily spread those pathogens across millions of burgers, packing plants now spend millions on "food safety" -- which is to say, on the problem of manure in meat.

Most of these efforts are reactive: it's accepted that the animals will enter the kill floor caked with feedlot manure that has been rendered lethal by the feedlot diet. Rather than try to alter that diet or keep the animals from living in their waste or slow the line speed -- all changes regarded as impractical -- the industry focuses on disinfecting the manure that will inevitably find its way into the meat. This is the purpose of irradiation (which the industry prefers to call "cold pasteurization"). It is also the reason that carcasses pass through a hot steam cabinet and get sprayed with an antimicrobial solution before being hung in the cooler at the National Beef plant.

It wasn't until after the carcasses emerged from the cooler, 36 hours later, that I was allowed to catch up with them, in the grading room. I entered a huge arctic space resembling a monstrous dry cleaner's, with a seemingly endless overhead track conveying thousands of red-and-white carcasses. I quickly learned that you had to move smartly through this room or else be tackled by a 350-pound side of beef. The carcasses felt cool to the touch, no longer animals but meat.

Two by two, the sides of beef traveled swiftly down the rails, six pairs every minute, to a station where two workers -- one wielding a small power saw, the other a long knife -- made a single six-inch cut between the 12th and 13th ribs, opening a window on the meat inside. The carcasses continued on to another station, where a U.S.D.A. inspector holding a round blue stamp glanced at the exposed rib eye and stamped the carcass's creamy white fat once, twice or -- very rarely -- three times: select, choice, prime.

For the Blair brothers, and for me, this is the moment of truth, for that stamp will determine exactly how much the packing plant will pay for each animal and whether the 14 months of effort and expense will yield a profit.

Unless the cattle market collapses between now and June (always a worry these days), I stand to make a modest profit on No. 534. In February, the feedlot took a sonogram of his rib eye and ran the data through a computer program. The projections are encouraging: a live slaughter weight of 1,250, a carcass weight of 787 pounds and a grade at the upper end of choice, making him eligible to be sold at a premium as Certified Angus Beef. Based on the June futures price, No. 534 should be worth $944. (Should he grade prime, that would add another $75.)

I paid $598 for No. 534 in November; his living expenses since then come to $61 on the ranch and $258 for 160 days at the feedlot (including implant), for a total investment of $917, leaving a profit of $27. It's a razor-thin margin, and it could easily vanish should the price of corn rise or No. 534 fail to make the predicted weight or grade -- say, if he gets sick and goes off his feed. Without the corn, without the antibiotics, without the hormone implant, my brief career as a cattleman would end in failure.

The Blairs and I are doing better than most. According to Cattle-Fax, a market-research firm, the return on an animal coming out of a feedlot has averaged just $3 per head over the last 20 years.

"Some pens you make money, some pens you lose," Rich Blair said when I called to commiserate. "You try to average it out over time, limit the losses and hopefully make a little profit." He reminded me that a lot of ranchers are in the business "for emotional reasons -- you can't be in it just for the money."

Now you tell me.

The manager of the packing plant has offered to pull a box of steaks from No. 534 before his carcass disappears into the trackless stream of commodity beef fanning out to America's supermarkets and restaurants this June. From what I can see, the Blair brothers, with the help of Poky Feeders, are producing meat as good as any you can find in an American supermarket. And yet there's no reason to think this steak will taste any different from the other high-end industrial meat I've ever eaten.

While waiting for my box of meat to arrive from Kansas, I've explored some alternatives to the industrial product. Nowadays you can find hormone- and antibiotic-free beef as well as organic beef, fed only grain grown without chemicals. This meat, which is often quite good, is typically produced using more grass and less grain (and so makes for healthier animals). Yet it doesn't fundamentally challenge the corn-feedlot system, and I'm not sure that an "organic feedlot" isn't, ecologically speaking, an oxymoron. What I really wanted to taste is the sort of preindustrial beef my grandparents ate -- from animals that have lived most of their full-length lives on grass.

Eventually I found a farmer in the Hudson Valley who sold me a quarter of a grass-fed Angus steer that is now occupying most of my freezer. I also found ranchers selling grass-fed beef on the Web; Eatwild.com is a clearinghouse of information on grass-fed livestock, which is emerging as one of the livelier movements in sustainable agriculture.

I discovered that grass-fed meat is more expensive than supermarket beef. Whatever else you can say about industrial beef, it is remarkably cheap, and any argument for changing the system runs smack into the industry's populist arguments. Put the animals back on grass, it is said, and prices will soar; it takes too long to raise beef on grass, and there's not enough grass to raise them on, since the Western range lands aren't big enough to sustain America's 100 million head of cattle. And besides, Americans have learned to love cornfed beef. Feedlot meat is also more consistent in both taste and supply and can be harvested 12 months a year. (Grass-fed cattle tend to be harvested in the fall, since they stop gaining weight over the winter, when the grasses go dormant.)

All of this is true. The economic logic behind the feedlot system is hard to refute. And yet so is the ecological logic behind a ruminant grazing on grass. Think what would happen if we restored a portion of the Corn Belt to the tall grass prairie it once was and grazed cattle on it. No more petrochemical fertilizer, no more herbicide, no more nitrogen runoff. Yes, beef would probably be more expensive than it is now, but would that necessarily be a bad thing? Eating beef every day might not be such a smart idea anyway -- for our health, for the environment. And how cheap, really, is cheap feedlot beef? Not cheap at all, when you add in the invisible costs: of antibiotic resistance, environmental degradation, heart disease, E. coli poisoning, corn subsidies, imported oil and so on. All these are costs that grass-fed beef does not incur.

So how does grass-fed beef taste? Uneven, just as you might expect the meat of a nonindustrial animal to taste. One grass-fed tenderloin from Argentina that I sampled turned out to be the best steak I've ever eaten. But unless the meat is carefully aged, grass-fed beef can be tougher than feedlot beef -- not surprisingly, since a grazing animal, which moves around in search of its food, develops more muscle and less fat. Yet even when the meat was tougher, its flavor, to my mind, was much more interesting. And specific, for the taste of every grass-fed animal is inflected by the place where it lived. Maybe it's just my imagination, but nowadays when I eat a feedlot steak, I can taste the corn and the fat, and I can see the view from No. 534's pen. I can't taste the oil, obviously, or the drugs,

yet now I know they're there.

A considerably different picture comes to mind while chewing (and, O.K., chewing) a grass-fed steak: a picture of a cow outside in a pasture eating the grass that has eaten the sunlight. Meat-eating may have become an act riddled with moral and ethical ambiguities, but eating a steak at the end of a short, primordial food chain comprising nothing more than ruminants and grass and light is something I'm happy to do and defend. We are what we eat, it is often said, but of course that's only part of the story. We are what what we eat eats too.

Michael Pollan, the author of "The Botany of Desire," is a contributing writer for the magazine. His last cover article was about organic food.

The first power-steering system fitted to a production car debuted in the 1951 Chrysler Imperial, and the competition quickly followed suit. Not only did power steering do the obviousâ€”allow the driver to steer a heavy vehicle with much less effort and greater comfortâ€”but it also allowed engineers to improve steering response, which is how quickly the car changes direction when the driver turns the wheel. More Automotive Firsts. First Cars with Navigation, Heated Seats, and More. Power steering is a system that helps a driver turn the steering wheel with less effort, pointing a car or truck's front wheels in the direction the driver intends to go. Automakers utilize three systems in today's cars and trucks: hydraulic power steering, electric power steering, and electro-hydraulic power steering. These three systems each have benefits and drawbacks, but all serve the same function. Power steering simply implies that your carâ€™s steering uses electricity or hydraulic pressure to augment the effort needed to steer the vehicle. This reduces the stress on the driver and allows for easier low-speed maneuverability. How Does Power Steering Work? The functionality of power steering comes down to magical wizardry. Joking! Letâ€™s break it down.