

SCIENCE TO THE RESCUE

It's difficult to envision a world in which we're no longer so reliant on animals for meat. After all, with the exception of some relatively new plant-based protein products, animals have satiated our species' desire for meat since the dawn of *Homo sapiens* some two hundred thousand to three hundred thousand years ago. But when we consider how many other things we used to depend on animals for—things like clothing, tools, shelter, and transportation—we realize how, in the past few centuries alone, new technologies have allowed us to dramatically reduce our reliance on animals across the board.

Prior to the twentieth century, for example, societies around the globe were largely lit by a ubiquitous fuel source: whale oil. This generated a gigantic whaling industry, one made even bigger by the Industrial Revolution's demand for mechanical lubricants in all the new factories. And no nation was as obsessed—or successful—with whaling as America.

New Bedford, Massachusetts, became known as the “City That Lights the World,” and there were enormous fortunes to be made

from the New England whaling fleets that traversed the high seas in search of giant prey. Whaling played such an integral role in America's economy that both the British in the Revolutionary War and Confederates during the Civil War waged attacks on the United States' whaling fleets. Moreover, the whaling industry commanded outsized influence on the economic and political life of the nation. Long before the advent of the modern petroleum oil industry, the whale oil industry reigned supreme during both colonial and early republic days. "The value of the oil and bone brought back to port made whaling," writes Eric Jay Dolin in his whaling history tome, *Leviathan*, "by the middle of the nineteenth century, the third largest industry, after shoes and cotton, in Massachusetts, and according to one economic analysis, the fifth largest industry in the United States." (For reference, the fifth largest industry in America today—measured by contribution to GDP—is durable manufacturing, bigger than all retail trade, all construction, and even the federal government.)

Today, the United States—including New Bedford—still has a large number of boats solely used to seek out and shoot whales, though now the shooting is done with cameras, and the only place you're likely even to find a harpoon is in a museum. In the twenty-first century, the United States is a leader not in whale-killing, but in whale-watching.

So how did an industry so powerful—indeed one of the most potent lobbies in antebellum America—go from hegemony to irrelevance?

It'd be simple to construct a narrative about the suffering of animals and sustainability concerns, about how great men and women fought the good fight on behalf of whales and beat back the Goliath that was the whaling industry. Indeed, there were early concerns raised about the ethics of whaling, mostly related to the ruthless efficiency with which whalers massacred their prey. Such wars on whales were likely to deplete the oceans of them entirely, some warned.

In fact, an 1850 letter to the editor of the *Honolulu Friend* newspaper, signed by a bowhead whale, begged the persecutors of arctic whales for mercy. Lamenting how many of his kind had been “murdered in ‘cold’ blood,” the cetacean “author” of the letter noted that whales had recently held a meeting “to consult respecting our safety, and in some way or another, if possible, to avert the doom that seems to await all of the whale genus throughout the world.” He continued, “I write in behalf of my butchered and dying species. I appeal to the friends of the whole race of whales. Must we all be murdered . . . ? Must our race become extinct? Will no friends and allies arise and revenge our wrongs?”

The whales would soon get their wish, but not for the reasons enumerated by our precocious sea-dwelling letter writer. The whaling industry’s downfall was just about to begin, bringing it from its greatest heights to near obscurity in a mere couple of decades.

A cartoon in an April 1861 issue of *Vanity Fair* paints the picture quite vividly: It shows a ballroom filled with celebrating whales, all dressed in black tie, some raising their glasses, others clinking them together in cheerful gaiety. Banners adorn the ballroom, one proclaiming, “We Wail No More for Our Blubber.”

The reason these whales were celebrating their liberation is straightforward: they had an innovative entrepreneur to thank for their lives—Canadian geologist Abraham Gesner.

Today, Silicon Valley investors salivate at buzzwords like “disruption.” Had venture capitalists known Gesner, his patent on kerosene would’ve had them falling over themselves to empty their wallets into his newly commercialized product.

Kerosene, which is derived from petroleum, offered a much better yet more affordable alternative to whale oil. In 1854, when Gesner commercialized kerosene, the US whaling fleet annually slaughtered more than eight thousand whales in the high seas around the globe. But in the ensuing years, as more Americans switched from whale oil

to kerosene to light their homes, the country's whaling fleet, which had grown annually during the entire first half of the nineteenth century, began rapidly contracting. From a high of 735 boats in 1846, within just three decades, the nation's whaling fleet was down to just thirty-nine ships. (That limited whaling continued largely to supply the women's corset market with whalebones, though that was later phased out by the invention of spring steel in the early twentieth century.)

That's right: in just thirty years, the whaling industry was decimated, shrinking *95 percent*, largely, though not entirely, because a better, cheaper alternative arose and supplanted it. Thanks in substantial part to Gesner's innovation and subsequent oil discoveries, untold numbers of whales were spared from grisly deaths and perhaps extinction altogether. As Dolin writes, "the viscous black oil that gushed out of the earth provided a challenge that could not be circumvented, becoming so plentiful, so versatile, and so cheap that it quickly replaced whale oil in many of its applications." And in the spirit of creative destruction in a free market economy, the kerosene lamp industry got a taste of its own medicine when it was subsequently later rendered extinct by Thomas Edison's electric light bulb.

A similar story is found in our cities' streets, once dominated by the sounds of cracking whips and screaming men, both targeted at the unfortunate horses who labored to transport us and our goods through heat and cold, rain and snow.

The American animal welfare movement was largely started in the late 1860s by pioneers like Henry Bergh, who deplored seeing the open and flagrant abuse of equines on a daily basis and consequently founded the American Society for the Prevention of Cruelty to Animals (ASPCA) in 1866. Animal welfare crusaders like Bergh campaigned for all types of reforms: watering stations for horses, mandatory resting hours, Sabbath resting days for them, and more.

There were so many horses in New York City that as author Jeff

Stibel notes in his book *Breakpoint*, in 1880 a committee of experts commissioned by the US government was assembled to predict what the city would look like by 1980. Their unanimous prediction: New York City would cease to exist within one hundred years, buried under a pile of horse manure. They calculated that given the city's unsustainable population growth rate, it would need to increase its equine labor population from two hundred thousand to six million within one hundred years. Already the city was burdened by the problem that each horse deposited more than two dozen pounds of manure and over a gallon of urine onto the streets daily. A thirty-fold increase in the number of horses would render the city unlivable.

Yet in the end, what freed horses from labor in our streets and what saved New York City from literally drowning in horse poop wasn't humane sentiment nor environmental concern. Just as kerosene helped save the whales, internal combustion engines helped replace horses as our primary means of transport. It was an inventor's imagination, not a social movement's moral argument, which rescued horses. And it's not as if the public was clamoring for cars before they existed. As Henry Ford himself famously declared: "If I had asked people what they wanted, they would have said faster horses."

Even today we still use terms like "horsepower" to describe how powerful a car is, yet, thankfully for horses, they were long ago freed by an innovative technology that the nation—and world—rapidly embraced. Wayne Pacelle, CEO of the Humane Society of the United States, remarks in his book *The Humane Economy*, it "was primarily Henry Ford and not . . . ASPCA founder Henry Bergh who was at the wheel in dramatically reducing cruelty to horses in the nineteenth and early twentieth centuries."

The new auto industry created its fair share of jobs, but not without decimating jobs in other sectors along the way. With the demise of the horse-drawn carriage also came the fall of a whole host of supporting fields. From buggy whip producers to the hay growers

providing the feed for all the horses, within just a couple of decades, long-standing industries were mere shells of their former selves.

These historical examples have weighed heavily on the minds of many social reformers in the more modern era. If you want to solve social problems in today's world, would you be better off going into traditional career paths like nonprofit work, policy, or politics, or will you have a greater chance to make an impact in the for-profit fields of technology, engineering, and entrepreneurship? There's no doubt to me the former are important (I have, after all, spent the bulk of my career as a policy advocate), but the fact of the matter is, as long as people demand real meat, the market is going to supply it, and globally speaking, demand for meat is only going up.

Is it possible that factory farms will one day seem as archaic to us as a whaling ship; a slaughter plant as antiquated as a horse-drawn carriage? This is exactly what those in the cellular-agriculture community hope, and it's why one young idealist, burdened by the knowledge of how unsustainable meat production is, decided to start a movement.

In 2002, Jason Matheny, a twenty-seven-year-old Johns Hopkins University public health graduate student, scored a job with the Avahan project, an effort by the Bill & Melinda Gates Foundation to reduce the rate of HIV in India. His task: to try to make HIV control programs more effective in order to avert substantial suffering and save lives.

Packing up his minimal belongings, Matheny set off to the sub-continent where he'd spend the next six months working in some of the poorest communities in the world. His time with Avahan was largely spent collecting data and crunching numbers, something that suited the young researcher's analytical mind well. Yet even as he witnessed what he calls "truly unbearable human suffering," he was also repeatedly stunned by the "shocking misery" so many animals

were enduring in India, from mange-ridden street dogs to starving and ownerless cows who wandered the streets and often died from intestinal blockages after ingesting plastic bags.

The only silver lining, he figured, was that animal suffering in India was limited to strays, and not on the same scale as what he calls “an agribusiness system that sentences billions of American farm animals to lives that just aren’t worth living.” It was disturbing, but at least it wasn’t systematized.

Or so he thought.

A couple months into his trip, Matheny visited a village outside of New Delhi. As the sun beat down, he sat inside a modest shack, interviewing a woman who’d lost her husband to HIV. Seeing the now-fatherless children and hearing their mother lament how she couldn’t earn enough to feed them all on her own, Matheny wanted to break down.

“The heat was intense, and I could feel my grip on the pen getting looser from all my sweat,” he recalls. “Her story made me so distraught, and my handwriting became less and less legible. I remember the thought creeping into my mind: Couldn’t we get a breeze in here?”

At just that moment, as if he’d been able to summon nature itself, a gentle gust of wind entered through the shack’s open door, giving Matheny a brief respite from his discomfort. The relief didn’t last long. Almost immediately, he detected a strong, foul odor that had entered on the draft.

Sensing her interviewer’s disgust, the widow grasped his hand. “I’m sorry,” she offered, “that’s just the chickens.”

“Really?” he replied, his interest piqued. “That’s a chicken’s manure?”

“Well”—she looked down—“*a lot of chickens’ manure.*”

He asked if he could see these chickens, so the widow took Matheny outside and pointed to a long, windowless warehouse three hundred or so yards away. It was about as local a farm as it could get.

The structure looked just like an American factory farm. Giant fans whirled furiously at the end of the building, pumping an artificial wind into one side and taking noxious fumes out the other end. His host led him toward the structure, the stench worsening as they approached. After a short walk to the source of the odor, she opened the door, and Matheny was stunned by what he found inside.

A blanket of tens of thousands of white chickens carpeted the floor from wall to wall. There was so little space in between each bird that it was difficult to notice the brown floor underneath them comprised of litter and feces. Dim bulbs on the ceiling offered sufficient light to know these were birds, but Matheny had to strain to notice they were individuals.

As far as Matheny's eyes—already burning from fecal ammonia in the air—could see was a mass of animals. It didn't appear that there was room for a human to walk among the birds without trampling them, but his host hastily walked in, beckoning her guest into the warehouse as if nothing was out of the ordinary.

Birds scattered, piling up on top of one another to make way for their visitors. They were so bulky that many had difficulty even taking a few frantic steps out of the way before collapsing. One appeared as if she was suffering cardiac arrest after being trampled by other birds jockeying toward her for space.

Matheny was inside the warehouse for just a few minutes, but the experience left an indelible mark on him. "Here I thought industrial animal agribusiness was only in the developed world, yet these chickens were living proof otherwise."

That night, back inside his modest Delhi apartment, Matheny took advantage of the fact that electricity was reliably flowing for the evening and began poring over the United Nations' Food and Agriculture Organization's website. A vegetarian himself, he knew that India had a rich history of vegetarianism, but he was surprised to learn that

Indian meat consumption, especially of chickens, was skyrocketing in accordance with the nation's ascent out of the third world. The same was true in other hugely populated countries like China, which also had a history of relatively low meat consumption.

"It was like feeling the earthquake out in the ocean and knowing that the tsunami was soon to strike land," Matheny analogized. "It began dawning on me that even if we could curb meat demand in America and Europe, if we didn't stop this trend of more meat in the developing world, where nearly all population growth will come from in the coming decades, those gains would be overshadowed by huge amounts of disease, environmental harm, and animal suffering. That's what got me wondering if there might be some type of technological fix that could be applied to the problem."

Months later, back in the United States, Matheny continued wondering what, if anything, could be done to protect the planet from such a troublingly unsustainable predicament. A true believer in the power of technology to improve society, he regularly read websites devoted to the latest and greatest tech advancements. Later that year, one particular headline caught his attention: "An In Vitro Edible Muscle Protein Production System (MPPS)."

Between 1999 and 2002, the article explained, a group of New York researchers funded by NASA turned into reality what a handful of futurists had only fantasized about since Churchill's prediction about lab-grown meat three-quarters of a century earlier. Led by Morris Benjaminson of Touro College in New York City, they'd isolated muscle cells from a goldfish and grown them outside the animal's body. The method was simply to take segments of goldfish skeletal muscle and bathe them in various nutrients that in the body would cause muscle growth, and that's exactly what happened. The researchers did fry up the fish meat they'd cultured to see how it would cook and smell—they said it was similar to conventional fish—though none of

them ate the results of their experiment, lacking Food and Drug Administration approval. "Their goal in this case was to allow astronauts to cultivate meat in space," Matheny remembers, "but I kept thinking as I was reading the article, 'In space? Why not do this on Earth?'"

He started scanning the scientific literature to see if he could find any articles about growing meat in a lab for terrestrially bound human consumption. After turning up nothing, Matheny emailed the authors of the NASA paper and other tissue engineers, asking why no one had written any scientific articles about mass-producing what he referred to at the time as "in vitro meat."

Most wrote back, with largely similar responses: *Why would you want to do that? If people want alternatives to meat, they could just eat soy burgers.*

As an avid consumer of those soy-based products himself, Matheny indeed hoped people would switch to these and other plant-based alternatives, but he knew that a problem as big as increased global meat consumption required more than just one possible solution. Just like there are now many renewable alternatives to fossil fuels (think solar, wind, geothermal, and more), could there be more than one alternative to factory farming of animals? For whatever reasons, despite the existence of affordable and nutritious vegetarian food, it seemed that whenever a population began escaping poverty, it also began adding more animals to its diet.

"Humans really love to eat meat," he says. "It's a hard habit for many to break. There were already resources going into promoting and improving plant-based meat alternatives, but no one was exploring whether investment in this other idea of growing real animal meat was a viable alternative to factory farming."

Matheny also noted that, at the time, despite increasing awareness about the ills of factory farming, American meat consumption was going up, not down. And, as noted in the previous chapter, while there's been some modest overall reduction in our consumption of

meat, we are still a primarily meat-loving nation. In short, the problem was (and remains) so urgent and severe that we don't have time to wait for a massive dietary shift toward plants.

"You can spend your time trying to get people to turn their lights out more often," Matheny observes, "or you can invent a more efficient light bulb that uses far less energy even if you leave it on. What we need is an enormously more efficient way to get meat." Just as Gesner did with whale oil and Ford did with horses and buggies, Matheny wanted to render conventional meat obsolete by developing an alternative that still satisfies consumer demand for meat.

During World War II, Americans became accustomed to meat rationing as part of the effort to support the troops abroad. When the war ended, the country was obviously flying high after its victory over Germany and Japan, but the problem of meat availability remained.

Wartime government-induced price ceilings on meat meant that many farmers simply chose not to produce in fear of losing money, but Americans were willing to endure the less-meat diet out of a shared desire to defeat the Axis enemies. When the war ended, however, those ceilings were lifted, and unsurprisingly the price of meat skyrocketed. In the midst of the 1946 midterm elections, President Truman, trying to save the Democratic Party, moved to enforce price ceilings again, but this time without the ability to rely on patriotism to encourage farmers to produce meat for untenably low prices. Enraged, the meat lobby retaliated by having producers again cease sending animals to slaughter.

As *TIME* magazine's Emelyn Rude wrote of the incident in 2016, "Miners declared they could not work without more meat and began striking in Washington. Hospitals stirred scandal by claiming they could only find horsemeat to serve their sick patients. The lines outside the butcher shops still in operation stretched for blocks and pro-

voked shoving and scratching amongst the patrons." The country was on edge. *TIME* itself even editorialized on the topic at the time, blaming what it called the "widespread meat famine" directly on Truman. (Keep in mind that what was considered a high-meat diet in America in the 1940s would be considered a reduced-meat diet today, since per capita consumption has risen every decade since then.)

Congressional Democrats begged the president to do something about the meat crisis, declaring it the single issue of concern to their constituents. The Republicans campaigned on a pro-meat message, throwing metaphorical red meat to voters who were deprived of the real thing. "Got enough meat?" asked Representative John Vorys, a Republican from Ohio in a campaign speech, a slogan which quickly came to be an election rallying cry. Representative Sam Rayburn even dubbed the midterm election of 1946 the "Beefsteak Election."

Blaming the meat barons of the time for the problem, Truman called them "the same group [that] hated Franklin D. Roosevelt and everything he stood for," and castigated them as a "reckless group of selfish men." But those men had played their hand well, and the meat shortage they caused by withholding animals from slaughter forced the president to relent, lifting all meat price ceilings. But it was too late: in substantial part due to the perception of a meat shortage, the Democrats lost control of both chambers of Congress.

This story, dramatic as it may seem today when many Americans are accustomed to having access to nearly unlimited amounts of any food we want whenever we want, illustrates just how strong the human desire for meat can be, and how hard it is to convince people to voluntarily reduce their meat consumption once they've developed a daily meat habit. And this isn't just true in America. Every culture that cultivates a taste for high meat consumption seems to favor it strongly. As Jason Matheny found when he was in India, when societies that've historically been too poor to sustain high rates of meat

consumption start getting richer, the first thing they do is add more meat to their diet.

Even tribal people who enjoy nearly none of the benefits that modern prosperity has brought to developed countries, including high meat consumption, still often tie their own welfare to how often they can eat meat. *National Geographic* reports that the Tsimane Indian tribe in the Bolivian Amazon considers meat essential to their sense of well-being. “The children are sad when there is no meat,” one mother told a journalist through an interpreter.

As the world continues to add more and more people, many of them in the developing world where demand for meat is growing at a fast clip, the question of how we’re going to avoid “meat famines” like the one that affected American politics in 1946 is a pressing one.

As noted, projections show that by 2050, nine to ten billion humans will inhabit the planet. The problem is that as our population expands, our access to other planets’ resources isn’t expanding with it. The earth is just, to borrow a phrase from astronomer Carl Sagan, a pale blue dot in our solar system and we’re exploiting it with alarming rapidity today, emptying its oceans of fish and razing its forests for cropland and pasture, mostly for animal agriculture.

Already today, according to the Food and Agriculture Organization of the United Nations, more than a quarter of the earth’s ice-free land is used for livestock grazing, and a third of our cropland is devoted to feeding our farm animals. As *New Scientist* reported in 2017, “if we were all determined to avoid animal proteins, the majority of agricultural land would be released from production, freeing up huge areas for wildlife.” On the other hand, if most of the billions of incoming people on earth expect to eat anything even close to what richer populations do today, just where are we going to produce all this meat?

The green revolution may have allowed our population to expand without global famine, but even its architect, Norman Borlaug,

warned that the expanding population would render advancements like his hybridizing of wheat insufficient. In his 1970 Nobel Peace Prize acceptance speech, the man credited with saving a billion human lives from starvation ended on a somber but hopeful tone:

The green revolution has won a temporary success in man's war against hunger and deprivation; it has given man a breathing space. If fully implemented, the revolution can provide sufficient food for sustenance during the next three decades. But the frightening power of human reproduction must also be curbed; otherwise, the success of the green revolution will be ephemeral only. Most people still fail to comprehend the magnitude and menace of the "Population Monster." . . . Since man is potentially a rational being, however, I am confident that within the next two decades he will recognize the self-destructive course he steers along the road of irresponsible population growth and will adjust the growth rate to levels which will permit a decent standard of living for all mankind.

Borlaug's confidence in humankind's rationality on this point so far seems largely unfounded. In the nearly fifty years since he made this speech, the human population has continued to rise and it shows little sign of abating in the coming couple decades. In the absence of our ability to slow or reverse this trend, now is the time to start thinking seriously about how we're going to feed our future selves. As Bruce Friedrich of the Good Food Institute wrote in *Wired* in 2016, "We're not going to feed the world, and we're not going to avoid a climate catastrophe, if we continue our global reliance on a system of food production that is so vastly inefficient and polluting. Individual change is important, but institutional change is even more important."

It was exactly this type of institutional change that Matheny hoped to inspire. After coming across the original NASA research about in vitro meat production in 2002, he continued corresponding with the scientists behind that study. After reading more and more literature about tissue engineering, he and a few of them became convinced that growing real meat from farm animals outside their bodies could indeed be done.

In the meantime, in 2003, an Australian artist named Oron Catts, along with a tissue engineering friend, Dr. Ionat Zurr, decided to grow some frog leg muscle in vitro and serve it up to diners in France as part of an art exhibit. While the tasters reportedly spat the meat out in disgust, the controversial exhibit garnered the headlines Catts desired, landing his project on Matheny's radar and only intensifying his interest. "The frog legs didn't seem that appetizing to me, but they definitely proved the point that you can do this with pretty much any animal," Matheny says.

Thinking about a beer brewery he'd once toured, Matheny daydreamed of beef breweries churning out clean, safe meat—all while freeing animals from factory farms and giving the earth a needed reprieve from the oncoming economic and environmental disaster that rapidly increasing global meat demand would ensure.

All he needed to do was spark enough interest to get money flowing to the right kind of research. Toward that end, in 2004, Matheny founded the first organization devoted to promoting research into growing real meat without animals. After conducting informal focus groups of a number of his friends in the sustainability and animal welfare fields, he settled on a name: New Harvest. "The name really encapsulated exactly what I was trying to bring about: a new type of bountiful harvest for humanity. One that would feed us with safe and nutritious food without destroying the earth in the process."

New Harvest's first task would be simply to get governments and other potential funders as excited about the prospect of lab-grown

meat as Matheny was. His efforts to gain the attention of the US Department of Agriculture didn't go far, perhaps because the agency has long championed increased American farm animal production, or perhaps because in the absence of a single company in the lab-grown meat field, such research would seem too far removed from the agency's interests. For whatever reason, Matheny wasn't able to get an audience.

As a result, he started scanning other nations' governments for assistance. The European Union has been very skeptical of certain new food science applications, such as genetically modified crops, but the European Union did seem to have much more willingness to regulate its animal-agriculture sector than the United States. For years, concerns about the environment and animals had led the European Union to adopt reforms that might mean it would be open to eco-friendlier ways to produce protein. Matheny learned that the Netherlands, pressed by a number of committed environmentalists in its government, had for years been investigating alternative protein sources derived from plants rather than animals. In response, the Dutch government initiated a project, Protein Foods, Environment, Technology, and Society (PROFETAS), which championed pea protein production as an efficient protein of the future, in part since peas could be easily grown in the Netherlands.

After founding New Harvest, Matheny wrote PROFETAS asking why they didn't consider "in vitro meat." The leaders of the group were interested in Matheny's suggestion, especially since they must have been aware that an eccentric Dutch scientist, Willem van Eelen, had for years been trying, with only modest success, to culture meat. Matheny was familiar with Van Eelen's work and had, in fact, written to him several times without getting a response.

Born in Indonesia to Dutch parents, Van Eelen had been captured by the Japanese while serving in World War II. Living in a POW camp, he thought about food all the time—especially how to get the most

out of the meager portions offered. Seeing emaciated dogs—their ribs visible, begging for scraps from hungry prisoners—took a toll on the inmate. Van Eelen fantasized about producing meat essentially from thin air so that no one would have to go hungry.

After the war, now living in Amsterdam, Van Eelen pursued a medical degree, during which he saw, as part of his education, an actual muscle gain mass outside the body. Since meat is primarily just muscle, why, he figured, couldn't we produce food that way? And so even while he practiced as a medical doctor, he spent decades tinkering, never working full-time on the project, trying to make muscle grow in vitro.

Finally, in 1999, Van Eelen persuaded the European Union to grant him a patent on a basic cultured meat production method. Part of what he was doing involved taking whole pieces of tissue from an animal and making them grow at the edges. Even though he never got the muscle to continue growing—there was a limit to the cell divisions possible—he'd succeeded in expanding its mass. (The patent was broader than this one process, and in fact was so potentially useful that in 2017 a new player to the clean meat space, Hampton Creek, purchased it, elating Van Eelen's daughter, Ira van Eelen, who maintains great hope that her father's dream will be actualized.)

Admittedly, Van Eelen had had a hard time persuading the Dutch government to fund his research, but Matheny wondered if he might have more success when the Dutch invited him to present at the 2004 PROFETAS conference in Wageningen. While there, the young American managed to get a private meeting with the Netherlands' minister of agriculture, where he presented the case for government funding of cultured-meat research. If the Dutch are serious about wanting to help protect the planet, Matheny argued, plant-based proteins are a good start, but the problem is too big to put all hope on them alone. It'd be like trying to move away from fossil fuels and putting all your research into just wind power, while ignoring the role other clean

energy sources, like solar, might have to offer. The world needed research into lab-grown meat.

Months after he left, to his great surprise and delight, Matheny got word that his efforts had paid off: \$2 million euros would soon be devoted to the experiments, which would be carried out at three Dutch universities.

The pledge of funds from the Dutch government was a huge step forward for New Harvest, energizing Matheny and causing him to begin seeking to rectify the total dearth of academic literature on the topic. Citing the tissue engineering work the medical community had been pioneering for years, he persuaded some of that community's scientists to join him in writing a blueprint for how mass-cultured-meat production could actually work. And so it came to be that the first-ever scientific article outlining just how one could produce cultured meat was written.

"*In Vitro*—Cultured Meat Production," was published in the journal *Tissue Engineering* in 2005. In the paper, three tissue-engineering researchers—Peter Edelman, Doug McFarland, and Vladimir Mironov—joined Jason Matheny in laying out the case for the potential of this new technology. The scientists explained that tissue-engineering technologies used in biomedicine could more easily succeed in cultured-meat production. A key barrier in biomedical efforts is that when creating tissues in the medical field, they must be alive and fully functional to work as a transplant. For food, on the other hand, you just need muscle growth. For example, growing a kidney that's going to be transplanted into someone's body requires that the researchers get that kidney as near identical to a natural, fully formed and functional kidney, which is a major technological barrier. Growing muscle, they noted, just requires taking the cells from skeletal muscles (the kind of meat we typically eat), isolating them, and affixing them to a scaffold that could help anchor them while they proliferate just as they would in an animal's body. Those scaffold

folds could be made of collagen mesh or even microcarrier beads, all while being rotated in a bioreactor (a fancy word for a steel drum in which cell culture takes place) with electrical stimulation that keeps the cells exercising and warm. The technique they envisioned could produce ground meat only, the authors warned, since the cells in the center of the thicker muscles would be deprived of nutrients and become necrotic in the absence of blood vessels to transport nutrients their way.

And while Matheny's primary goal was to generate interest among tissue engineers, as a grad student at the University of Maryland at the time, he knew his school's public relations department would love the attention this would bring. Their press release did the trick.

"With a single cell, you could theoretically produce the world's annual meat supply," the UMD press release touted. "And you could do it in a way that's better for the environment and human health."

Overnight, Matheny essentially became the face of the cultured-meat movement. Soon, he was being quoted everywhere, from the *Washington Post* and NPR to *CBS Evening News* and *BEEF* magazine, the trade publication for the cattle industry in which he bravely suggested "that perhaps the future farmers of America are microbiologists rather than cattle ranchers."

The *New York Times* profiled him in its annual "Ideas of the Year" feature. *Discover* magazine named in vitro meat one of the most notable tech stories of 2005. When they asked Matheny if people would balk at the thought of eating meat grown in a lab, he rebutted, "There's nothing natural about a chicken that's given growth promoters and raised in a shed with ten thousand others. As consumers become educated, a product like this would gain appeal." Even so, years later, Matheny is still asked the same question in essentially every conversation on the topic: Will anyone actually eat something like this?

The widespread media attention led Matheny to start traveling the country, discussing the benefits of cultured-meat research. He even

managed to get an audience with two of the largest meat producers on earth: Tyson Foods and Perdue Farms. He suggested they fund their own R and D and compete against each other to bring the first cultured poultry to market. Matheny also informed them that the Dutch subsidiary of Smithfield Foods—the world's largest pork producer—had supported cultured-meat research in the Netherlands, and he wondered whether its counterpart in the United States might do the same.

The poultry producers told him that, while many people think of their companies as being in the animal production business, they really see themselves as being in the protein production business. To them, it didn't matter so much where that protein came from so long as it was healthy, safe, and nutritious. The thought of getting these meat Goliaths involved tantalized Matheny. He knew they could bring R-and-D resources that would dwarf the limited spending by governments and academia on cultured-meat research so far, so he made his case and braced himself for the response. The poultry company reps were polite and listened, though at the end of the calls, they indicated that it was just too early for them to act on this advice.

In many ways, their decision was understandable. This concept was in its infancy, the science largely theoretical, and the thought that consumers would even want to buy such meat was far from clear. These companies already had a proven method of bringing meat to the table and this method must have seemed far more like something out of a *Jetsons* episode to them than a legitimate business idea they'd pursue.

Undeterred, Matheny reached out to other movers and shakers in the tech and food worlds throughout 2005. He also got a chance to visit the lab of the NASA-funded researchers in New York that had sparked his interest in the whole topic three years earlier.

He wasn't sure what to expect, but he certainly anticipated something more grandiose than what he found. The genesis of his interest in growing meat in vitro was hardly a sight to behold. The space where three years earlier goldfish muscles grew was just two small

tables pressed against each other. Were they dining room tables, Matheny recalls, it'd have been difficult to seat four people.

As he chatted with the researchers, Matheny stared at those two small tables and fantasized about the massive meat breweries he hoped they'd spawn in the near future.

In his meetings with venture capitalists and agribusinesses alike, the biggest pushback Matheny got when describing in vitro meat was that it was just "unnatural." He found this criticism deeply frustrating. "Flying, using email, air-conditioning, reading books, eating foods that grew on the other side of the world—they're all unnatural and extremely new on the timeline of humanity's existence," Matheny points out. "We should celebrate these innovations and appreciate how much better they make our lives."

Still, it's just very difficult to shake that initial reaction to hearing about something like growing meat in a lab. In 2005, the European Commission polled residents about their views on potential future applications of technology, asking if they approved of a variety of applications in some, all, or no cases. Perhaps in response to Matheny, the commission included a question about whether Europeans approved of "growing meat from cell cultures so that we do not have to slaughter farm animals." More than half the respondents said they'd "never" approve of it, though a quarter said they'd approve in some or all cases. Shockingly, more people approved of "developing for children a genetic test that would identify their talents and weaknesses," and even "using genetic testing to produce a child that could act as a bone-marrow donor" than they did producing meat in a lab. It's possible that this skepticism among consumers stemmed from their lack of awareness of the technology—after all, back in 2005, Matheny was one of very few people championing research into the field and no one (besides the participants in Oron Catts's frog legs art exhibit) had tasted meat grown outside an animal. It's also possible that the framing of the question influenced more negative answers since, as we'll

see later in the book, more recent polls that provide better context on the issue have been met with far greater support.

Regardless, in light of findings like this, and as Matheny did more and more media interviews, it became clear to him that one reason so many people were grossed out had to do with terminology. While he kept calling the hypothetical food “in vitro meat,” which was scientifically accurate, he realized it was akin to calling table salt “sodium chloride”—technically correct, but hardly enticing. Whenever he’d refer to “in vitro meat,” people immediately thought of in vitro fertilization—and not that many people want to think about babies while contemplating the meat in their sandwich. Matheny needed a new name for the meat he hoped consumers around the world would one day enjoy.

In the same way he used friends as a focus group for naming New Harvest, Matheny went back to his informal focus groups to brainstorm a better name for the meat. “Lab-grown meat,” “test tube meat,” and “synthesized meat” all fell into the same category, producing an “ick” factor that immediately prejudices people against the food. One suggestion, to appeal to environmentally minded eaters, was “green meat,” though it quickly became clear that it, at best, conjured images of Dr. Seuss and, at worst, rotten meat. As a play on “in vitro meat,” one friend jokingly suggested simply calling it “in meatro.”

For a time, Matheny favored “hydroponic meat.” After all, millions of Americans by that time had become accustomed to buying hydroponic tomatoes, and some even correctly associated them with lower water use. But it was still just too technical. It wasn’t hard to envision tomatoes growing without soil, but meat growing without an animal? Even more entertainingly, one friend reminded him at the time that a whole generation of young people, thanks to Snoop Dogg, had a very different connotation of the word “hydroponic.”

“Meat without feet,” “good meat,” “cultivated meat,” “clean meat”—the list went on. In an appeal to history, “Churchillian meat” even got discussed, though associating the food with a man who’d been dead

for decades wasn't the most popular option. Years later, in a tip of the hat to an episode of *The Colbert Report* that featured the issue and dubbed it "schmeat"—as in "meat schmeat," or sometimes "sheet meat," or, to Colbert, "shit meat"—in 2013 Oxford Dictionaries even awarded "schmeat" as its runner-up new word of the year.

In the end, Matheny's small group of friends settled on "cultured meat." Americans were used to eating cultured products like yogurt, beer, and sauerkraut, and the term brought connotations of good digestive health as well as a sense of refinement to contrast it with the lower-grade conventional meat. "In vitro meat" had earned its place in the history books, but Matheny now felt it was time to put it to rest. (For his part, Willem van Eelen was opposed to any name other than simply "meat," since he argued that's exactly what it was, and it required no special designation.)

Partially as a result of Matheny's conversion to "cultured," for the next decade, essentially everyone in the cellular-agriculture community came to adopt the term. In fact, at a 2011 Swedish conference that Matheny helped organize, the leading researchers in the field officially agreed to the switch. Since then, those in the industry attend symposia with names like the International Conference on Cultured Meat and researchers publish papers with titles such as "Cultured Meat from Stem Cells: Challenges and Prospects." And if you type "in vitro meat" into *Wikipedia*, it mercifully automatically redirects you to its page entitled "Cultured meat."

But six years after the official name change, some of the food's advocates weren't so convinced that "cultured" really was the best term to use. Although far better than "petri dish meat" and "lab-grown burgers," "cultured meat" can be confusing to consumers who think it's cultured like cheese or yogurt, and more important, a lot of people just have a negative reaction to the term "cultured meat."

As the field widened beyond meat and into leather, eggs, milk, silk, and more, "cultured-animal products" occasionally got displaced

by the more interesting and more accurate title of “cellular agriculture.” New Harvest hosted the first-ever conference on the topic, in 2016, entitled “Experience Cellular Agriculture,” and some began wondering if that might even become a moniker for the food: cellular meat, cellular eggs, etc. Ronen Bar of SuperMeat, an Israeli cultured-meat company, who was at the conference, joked to me at the time, “Cellular meat? You may as well call it cancer meat.”

Critically, though, no one had ever done any actual consumer testing of the issue. “Cultured” came to be the term of choice because the scientists working on the issue thought it sounded best, but no polls or focus groups had ever been conducted. That is, until 2016, when the Good Food Institute conducted the first consumer poll to determine what might be the best term to use when talking about this new technology to the public. The poll tested the five terms offered for the survey by the leading scientists in the field: “cultured meat,” “pure meat,” “clean meat,” “safe meat,” and “Meat 2.0.” (No one even suggested “cellular meat.”)

The results were pretty stark. In the two surveys GFI conducted, “cultured” ranked fourth out of five in terms of consumer acceptance. In first place was a term Matheny had considered in 2005 but ultimately decided against: “clean meat.”

Interestingly enough, it turns out that as far back as 2008, there were efforts to start calling it “clean meat.” Wesleyan psychology professor Scott Plous published a letter to the editor in the *New York Times* in which he made that case. Bristling that the *Times* had referred to it as “fake meat,” Plous protested in his letter: “The commercial development of meat from animal tissue won’t result in ‘fake meat’ any more than cloning sheep results in fake sheep. Quite the contrary, lab-based techniques have the potential to yield far purer meat, uncontaminated with growth hormones, pesticides, *E. coli* bacteria, or food additives. A more accurate name for the end result would therefore be ‘clean meat.’”

GFI's Bruce Friedrich argued to his colleagues in the field that the term "clean meat" is similar to calling renewable power "clean energy." The general category, clean energy, comprises various kinds of earth-friendly energy sources: solar, wind, geothermal, etc. And since growing animal products requires so many fewer resources and causes so much less climate change than raising and slaughtering animals, the clean energy comparison seemed apt.

More important, asserts Friedrich, the food safety benefits of this meat—namely the lack of intestinal pathogens like *E. coli* and *Salmonella*—make the "clean" label even more appropriate. Unlike conventional meat, which is typically so riddled with bacteria that you have to decontaminate countertops that raw meat has touched, clean meat is perfectly safe to handle in raw form, with a greater risk of contamination coming from your own hands than the meat itself.

Upon beginning to use "clean meat" with the public, Friedrich noticed a much better response than when he used to use "cultured." The "eww" response he'd often get when telling people about cultured meat outside an animal was replaced by people asking what made it cleaner, enabling him to discuss the meat's benefits as opposed to merely its method of production.

I witnessed anecdotally what Friedrich was describing firsthand, at a conference I helped organize in Washington, DC, called "The Future of Food." Friedrich was on a panel with Susie Weintraub, an executive vice president of strategic marketing and business excellence for Compass Group, the largest food service company on earth. In 2016 *Fortune* magazine named Weintraub "one of the most innovative women in food," and she's often regarded as among the most powerful people in the food industry. When Friedrich talked about why GFI favors "clean meat" rather than "cultured meat," Weintraub had an instantly positive reaction. She exclaimed to the crowd, "I'm happy to hear that we've shifted to clean meat versus cultured meat. . . . It's just these little things, like something as simple as going from meat

grown in a lab—what the hell, right?—to ‘clean meat,’ a much better term. People are much more accepting of it.”

Quartz published a story in 2016 about Friedrich’s crusade to change the name with a title he admits was far from productive: “To Lure People Put Off By the Freakiness of Lab-made Meat, This Is What the Industry Wants to Call It.” But the story made a good point. Journalist Chase Purdy noted:

Research suggests the biggest influence on a person’s opinion of a particular food is how they “expect” it will taste. Giving fun, enticing names to healthy foods increases the desire to try them. Why not call broccoli “broccoli bites” or carrots “X-ray vision carrots”? Renaming foods to make them sound more appealing resulted in an increase in the sale of vegetables in the school cafeteria by 27 percent.

Subsequent polls and focus groups conducted in 2016 by Animal Charity Evaluators and in 2017 by New Harvest both confirmed what GFI had found: “clean” substantially outperformed “cultured,” leading most of the companies in the cell-ag field to switch from “cultured” to “clean.”

Naming debate aside, there are still many things that need to happen before clean meat becomes a viable consumer product—let alone popular enough to transform our food industry. New Harvest’s primary efforts in its early years involved helping organize European conferences and other events on cultured meat in an effort to increase awareness and attract sources of funding. But with Matheny running the organization alone in his spare time while he went to school and worked, no monumental progress ensued. Not a gram of meat was produced, no companies were formed, and the dream

of getting meat on store shelves still seemed distant. After graduating in 2009, now having obtained numerous academic degrees—BA, MBA, MPH, and PhD—Matheny began working for the Intelligence Advanced Research Projects Activity (IARPA), a federal organization.

Convinced that technology can vastly improve welfare, and that the only real threat to technological advancement is a global catastrophe, Matheny focused more of his energies on his work at IARPA to reduce risks from war, pandemics, and technological accidents. At the same time, as he felt like he was neglecting New Harvest, a molecular and cell biology student in Canada, Isha Datar, had written a paper on the potential for cultured meat and sent it to Matheny for his thoughts.

In 2010, the journal *Innovative Food Science and Emerging Technologies* published Datar's article "Possibilities for an In-vitro Meat Production System." The IVM name just wouldn't go away, but Matheny was still thrilled to see more serious academic interest in the topic. Because of her zeal, Datar quickly began representing New Harvest in venues around the globe. In 2012, Matheny appointed Datar the executive director—and first-ever employee—of New Harvest. After gaining attention as a 2013 TEDxToronto speaker, Datar attracted enough resources to the organization that New Harvest started giving out grants to researchers and putting on its own conferences.

As we'll see in later chapters, two of the companies in this book, Perfect Day (which makes milk) and Clara Foods (which makes egg whites), were cofounded by Datar, and some of the research now being done to solve key barriers to commercialization is being funded by New Harvest.

"The obstacles to disrupting animal agriculture with cellular agriculture aren't lack of expertise and certainly not lack of interest," Datar notes, sitting in New Harvest's modest New York City office. "The biggest deficiency is simply a lack of funding. Nearly all the funding for tissue engineering research is going into medicine, not food. We need to change that."

Toward that end, Datar created the New Harvest Cultured Tissue Fellowship, a collaboration with Tufts University in which one student will study in the school's Tissue Engineering Research Center as a postgrad. At the end of her studies, Natalie Rubio, the first fellow in the program, will hold the first-ever PhD in cellular agriculture.

When pondering whether people will eat the meat she's attempting to bring into the world, Datar feels confident. "If we're comfortable treating farm animals like bioreactors, and selectively breeding them for the purpose of maximal muscle growth, why wouldn't we just remove the animal altogether and just go for the muscle growth on its own?"

At the same time, Datar points out that the cellular agriculture revolution she's aiming to assist is about so much more than just food. Already there are companies making cultured leather, spider silk, and even musk perfume—all without the animals, and these products could be just the introduction to clean-animal products the public needs to get used to the idea. In so many ways, just like transportation and home lighting, industries that have relied for centuries on animal use now face an oncoming wave of start-ups seeking to make the current models obsolete.

Matheny is now IARPA's Director but still sits on the board of New Harvest. For his part, he self-reflects while sitting in a suburban Maryland burrito shop in 2017. Looking down at his \$6 rice-and-beans feast and the meat-filled burritos of other diners around him, he wonders how long it'll take before their burritos will be filled with clean meat.

"We can use technology to render some of our most pressing difficulties moot," he argues. "The habit of high meat consumption is a serious problem that many people just have a hard time breaking. But the cultured meat industry now has a chance of being able to provide people with the same food—probably even better food—without causing so many problems. If I played a small role in helping that happen, little would make me happier."